THE UNIVERSITY
OF ILLINOIS
LIBRARY
630.8
On81
v.28-30

Digitized by the Internet Archive
in 2014

https://archive.org/details/report2830onta

TWENTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM

1902.

(PUBLISHED BY THE ONTARIO DEPARTMENT OF AGRICULTURE, TORONTO.)

PRINTED BY ORDER OF

THE LEGISLATIVE ASSEMBLY OF ONTARIO.

TORONTO:
PRINTED BY L. K. CAMERON,
Printer to the King's Most Excellent Majesty.
1903.

WARWICK BRO'S & RUTTER,
Printers.

THE ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM

GUELPH, ONT.

HON. JOHN DRYDEN, Minister of Agriculture,
Toronto, Ont.

STAFF OF PROFESSORS AND INSTRUCTORS IN 1902.

JAMES MILLS, M.A., LLD ..... President
H. H. DEAN, B.S.A ..... Professor of Dairy Husbandry
C. A. ZAVITZ, B.S.A ..... Director of Field Experiments
J. HUGO REED, V.S ..... Professor of Veterinary Science
G. E. DAY, B.S.A ..... Professor of Agriculture and Farm Superintendent
H. L. HUTT, B S.A ..... Professor of Horticulture
J. B. REYNOLDS, B.A ..... Professor of Physics and Lecturer in English
F. C. HARRISON, B.S.A., D.P.H ..... Professor of Bacteriology
W. LOCHHEAD, B.A., M.S ..... Professor of Biology and Geology
R. HARCOURT, B.S.A ..... Professor of Chemistry
W. R. GRAHAM, B.S.A ..... Manager and Lecturer in Poultry Department
H. R. ROWSOME ..... Lecturer in Apiculture
M. W. DOHERTY, B.S.A., M.A ..... Associate Professor of Biology
W. P. GAMBLE, B.S.A ..... Associate Professor of Chemistry
M. CUMMING, B.A., B.S.A ..... Associate Professor of Agriculture
W. J. RUTHERFORD ..... Dean of Residence and Instructor in English and Mathematics
H. STREIT, D.M.V ..... Assistant in Bacteriology
W. C. GOOD, B,A ..... Assistant in Chemistry
ALICE ROWSOME, B.A ..... Assistant in Library and Instructor in French and German
T. D. JARVIS, B.S.A ..... Fellow in Biology
G. B. MCCALLA, B.S.A ..... Fellow in Physics
CAPTAIN CLARK ..... Instructor in Drill and Gymnastics

OFFICE STAFF.

S. SPRINGER ..... Bursar
B. S. PICKETT ..... Secretary
ANNIE HALLET ..... Stenographer
F. K. DOUGHERTY ..... Departmental Stenographer
W. O. STEWART, M.D ..... Physician

CONTENTS.

REPORT OF THE PRESIDENT vii

Manual Training, Household Science and Nature Study, vi—College Work and Progress, vi—Short Courses, vii—Students in Attendance, 1902, viii—Analysis of College Roll, viii—Ages and Religious Denominations, ix—Counties Represented in 1902, ix—County Nominations, ix—Our Courses of Study, ix—Department Reports, xii—The Macdonald Buildings, xii—Farmers' Excursions, xiii—Class-room Work, xiii—Bachelors of the Science of Agriculture, xiii—First-class Men, xiv—First Year, xiv—Second Year, xv—Scholarships, xv—Prizes, xv—Thanks and Further Requests, xv.

REPORT OF THE DEAN OF RESIDENCE AND INSTRUCTOR IN ENGLISH 1

REPORT OF THE PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH 2

The Work in English, 2—Instruction in Mathematics and Physics, 2—The Cold Storage Building, 6—Results of Experiments in the Cold Storage of Fruits, 8—Destruction by Lightning in Ontario in 1902, 9—Sub-soil Temperatures, 11—The New Physics Laboratory, 13.

REPORT OF THE PROFESSOR OF BIOLOGY AND GEOLOGY 16

Class-room and Laboratory and Instruction in Biology, 16—Outside Work, 18—The Museum, 19—Some Injurious Insects and Fungous Diseases of the Year, 19—Three Dangerous Trees in Fruit Districts, 28.

REPORT OF THE ASSOCIATE PROFESSOR OF BIOLOGY 29

Mustard Spraying, 29—Herbarium Work, 29—Ornithology, 30—Bird Migration notes, 30.

REPORT OF THE PROFESSOR OF CHEMISTRY 33

Teaching, 33—Miscellaneous Work, 34—Illustration Plot on Whitby Fair Grounds, 34—Illustration Sugar Beet Exhibit at the Industrial Fair, 36—Acidimeter, 36—Hamilton Sludge, 37—Fish Food, 37—Water in Butter, 38—Does the Amount of Nitrogenous Matter in Butter Affect the Keeping Quality, 39—Investigations Regarding the Ripening of Cheese, 40—Limestone, 41—Tests of Different Varieties of Sugar Beets, 42—Sugar Beet Experiments, 43.

REPORT OF THE ASSOCIATE PROFESSOR OF CHEMISTRY 48

Teaching, 48—Investigations Undertaken, 48—Moisture Determination, 53.

REPORT OF THE PROFESSOR OF VETERINARY SCIENCE 54

Class Room, 54—Diseases and Ailments of Stock, 55.

REPORT OF THE PROFESSOR OF DAIRY HUSBANDRY 56

The Dairy School, 56—Milk for Household purposes, 57—Testing of Cream at the Cream-gathering Creamery, 59—Pasteurization of Milk for Butter-making, 60—Temperature for Ripening Cream, 61—Percentage of Acid in Cream for Butter-making, 61—Different Percentages of Fat for Butter-making, 62—Moisture and Salt in Butter, 62—Exporting Butter in Pound Prints, 63—Experiments in Cheese-making, 63—Heating Over-ripe Milk to 110 Degrees at Cooking, 64—Washing Curds, 64—Moisture and Salt in Curd and Cheese, 65—Ripening (or Curing) of Cheese in the Dark and in the Light, 66—Coating Cheese with Paraffine Wax, 66—The Dairy Herd, 67—Needs of the Dairy Department, 68.

REPORT OF THE PROFESSOR OF AGRICULTURE AND FARM SUPERINTENDENT 69

Experiments with Fattening Steers, 69—Fattening Lambs, 71—Experiment with Swine, 72—Farm Superintendence, 73—General Notes on Feeding and Management 75—Financial Matters, 76.

246388

REPORT OF THE PROFESSOR OF HORTICULTURE 77
Instruction of Students, 77—Correspondence, 78—Conventions Attended, 78—Bulletins, Reports, and Articles Published, 78—Inspection of Fruit, Experiment Station, 79—Co-operative Experiments, 79—Experimental Work at the College, 80—Improvements in the Campus, 85.

REPORT OF THE PROFESSOR OF BACTERIOLOGY 88
Lectures, 86—Meetings Attended, 86—Publications, 87—Routine Laboratory Work and Analysis, 87—Assistance Offered to Veterinarians and Farmers, 88—Urgent Needs, 88— Research Work, 88—Acknowledgments, 93—Anthrax, 94—Short Notes on a New Chicken Disease, 95—The Identity of Human and Avian Diphtheria, 98.

REPORT OF THE EXPERIMENTALIST 105
Field Agriculture or Agronomy, 105—Experiments at the College, 106—Results of Experiments, 107—Selection of Seed Grain, 107—Grain Grown in Mixtures for the Grain and Straw, 109—Treatment of Oats and Winter Wheat for Smut, 110—Methods of Cultivation, 112—A Comparative Test of Ten Different Classes of Grain, 112—Varieties of Spring Wheat for Flour Production, 113—Macaroni Wheat, 114—Varieties of Spring Wheat for Feeding Live Stock, 114—Varieties of Spring Rye, 115—Varieties of Six-rowed Barley, 116—Varieties of Two-rowed Barley, 116—Varieties of Hulless Barley, 117—Winter Barley, 117—Varieties of Winter Wheat, 117—Miscellaneous Experiments with Winter Wheat, 118—Winter Rye, 119—Varieties of Buckwheat, 119—Varieties of Corn for Grain, 119—Varieties of Sunflowers, 119—Varieties of Millet for Seed, 120—Field Peas, 120—Grass Peas, 121—Egyptian Peas, 122—Cow Peas, 122—Lupines, 123—Vetches for Seed, 123—Lentils, 123—Horse Beans, 123—Varieties of Flax, 123—Varieties of Field Beans, 124—Soy Beans, 124—Varieties of Potatoes, 125—Selection of Seed Potatoes, 126—Planting One, Two, and Four Pieces of Potato in each Hill, 126—Influence of Coating Cut Potatoes with Lime, Plaster, etc.—Length or Time to Cut Potatoes Before Planting, 127—Potatoes Grown with Farmyard and with Poultry Manure, 127—Treatment of Potatoes to Destroy the Scab, 127—Different Methods of Treatment to Kill the Potato Beetle, 127—Varieties of Sugar Beets, 128—Planting Sugar Beets at Different Distances Between the Drills, 130—Varieties of Field Roots, 130—Selection of Seed of Field Roots, 131—Planting Whole and Broken Seed of Mangels and Sugar Beets, 131—Sprinkling Turnip Seed with Coal Oil to Prevent Injury by the Turnip Fly, 131—Planting Seed of Field Roots at Different Depths, 132—Flat and Ridged Cultivation for Sugar Beets, 132—Fertilizers with Swede Turnips, 132—Experiments with Corn for the Production of Fodder or Silage, 133—Varieties of Millet for Green Fodder, 133—Varieties of Rape, 134—Varieties of Sorghum for Fodder, 134—Some Leguminous Crops for Green Fodder, 135—Annual Crop of Pasture, 135—Grasses and Clover, 137.

REPORT OF THE MANAGER OF THE POULTRY DEPARTMENT 139
General Review of Work, 139—Hatching Eggs in January, 140—Later Hatching, 141—General Treatment of Breeding Stock, 141—Layers, 142—Buff Orpingtons, 142—Plymouth Rocks and Wyandottes, 142—Ducks, 142—Fattening or Fleshing Chickens, 143—Fattening Chickens in July, 143—Feeding all Cooked Food, 144—Substitutes for Skim-milk in Feeding, 145.

REPORT OF THE LECTURER ON AGRICULTURE 147
Stimulative Feeding, 147—Respecting Quilts used in Wintering in Chaff Hives, 148—Storing Honey in Paper Sacks, 148—Using Unfinished Sections, 148.

REPORT OF THE LIBRARIAN 149

REPORT OF THE PHYSICIAN 150

FINANCIAL STATEMENT 151

INDEX 155

TWENTY-EIGHTH ANNUAL REPORT

OF THE

ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM

FOR THE YEAR 1902.

GUELPH, December 31st, 1902.

To the Honorable JOHN DRYDEN,
Minister of Agriculture :

SIR,—I have the honor to transmit herewith the Twenty-eighth Annual Report of the Ontario Agricultural College and Experimental Farm.

In this Report the work of the year 1902 has been briefly reviewed under the following heads :

PART I. REPORT OF PRESIDENT.
PART II. REPORT OF DEAN OF RESIDENCE.
PART III. REPORT OF PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH.
PART IV. REPORT OF PROFESSOR OF BIOLOGY AND GEOLOGY.
PART V. REPORT OF ASSOCIATE PROFESSOR OF BIOLOGY.
PART VI. REPORT OF PROFESSOR OF CHEMISTRY.
PART VII. REPORT OF ASSOCIATE PROFESSOR OF CHEMISTRY.
PART VIII. REPORT OF PROFESSOR OF VETERINARY SCIENCE.
PART IX. REPORT OF PROFESSOR OF DAIRY HUSBANDRY.
PART X. REPORT OF PROFESSOR OF AGRICULTURE AND FARM SUPERINTENDENT.
PART XI. REPORT OF PROFESSOR OF HORTICULTURE.
PART XII. REPORT OF PROFESSOR OF BACTERIOLOGY.
PART XIII. REPORT OF EXPERIMENTALIST.
PART XIV. REPORT OF MANAGER OF POULTRY DEPARTMENT.
PART XV. REPORT OF LECTURER ON APICULTURE.
PART XVI. REPORT OF LIBRARIAN.
PART XVII. REPORT OF THE PHYSICIAN.

I have the honor to be, Sir,

Your obedient servant,

JAMES MILLS,
President.

PART I.

REPORT OF THE PRESIDENT.

Improved Condition of Ontario Farmers.

The condition and prospects of agriculturists in this country are improving. The farmers of Ontario, not to speak of the other Provinces of the Dominion, are in a much better position now than they were in fifteen or sixteen years ago: they are on a higher plane of intelligence; they dress better and live better,—they are getting a larger share of the necessaries and comforts of life for their labor; and as a class they stand higher socially than they did in the years gone by. Many agencies have been contributing to these gratifying results,—the Public and High Schools all over the Province, the Agricultural College, the Dairy Schools, Travelling Dairies, Farmers' Institutes, Women's Institutes, Live Stock, Dairy, and Poultry Associations, Entomological Society and Fruit Growers' Association, Winter Fairs, other great fairs, provincial sales of live stock, and the annual distribution by the Minister of Agriculture to all members of Farmers' Institutes throughout the Province free copies of all reports and bulletins issued by the Department of Agriculture, the Agricultural College, the Farmers' Institutes, and the various associations under the control of the Minister—many agencies and a great work.

Manual Training, Household Science and Nature Study.

By the help of Sir W. C. Macdonald of Montreal, the Minister of Education for Ontario, Prof. J. W. Robertson of Ottawa, Mrs. John Hoodless of Hamilton, and other less prominent workers, a distinct step in advance has been taken along the line of adapting our primary and secondary education to what are likely to be the functions and environment (the life work and surroundings) of the great majority of our young people—manual training for boys, household science for girls, and nature study for both. Manual training and household, or domestic, science departments are in successful operation at a number of our High and Public Schools; household science is taught in the Ontario Normal School of Domestic Science and Art, Hamilton, and in the Provincial Normal Schools and Normal College; and we hope soon to offer at the Macdonald Institute in connection with the Ontario Agricultural College a valuable course in nature study and a broader, longer, and more thorough course in household science than can be given at the Normal Schools or Normal College. This course, it is expected, will begin about the middle of September next; and as special provision will be made for farmers' daughters in Macdonald Hall (or the Women's Residence) along side of the Institute, it is hoped that much will be done towards improving the management, increasing the comfort, and multiplying the happiness of Canadian farm homes. If this is done, the standard of work and citizenship throughout the Province and Dominion will rise from year to year.

College Work and Progress.

The work in the various departments of the College has gone on pretty much as usual during the past year. The class-room and laboratory work has been heavier than formerly on account of the increased attendance

of students. Ten or eleven bulletins have been published during the year, and a considerable addition has been made to our buildings and appliances for practical work. The bulletins prepared and sent to the Department of Agriculture for publication in 1902 were as follows :

No. 117—"Pasteurization of Milk for Buttermaking" by H. H. Dean and F. C. Harrison.

No. 118—"Yeast and Its Household Use" by F. C. Harrison.

No. 119—"Ventilation of Farm Stables and Dwellings" by J. B. Reynolds.

No. 120—"Bitter Milk and Cheese" by F. C. Harrison.

No. 121—"Ripening of Cheese in Cold Storage Compared with Ripening in the Ordinary Curing Room" by H. H. Dean, F. C. Harrison, and R. Harcourt.

No. 122—"Spray Calendar—Directions for Treatment of Insect Pests and Plant Diseases" by W. Lochhead.

No. 123—"Cold Storage of Fruit" by J. B. Reynolds and H. L. Hutt.

No. 124—"Nature Study, or Stories in Agriculture" by members of the College Staff.

No. 125—"Roup" by F. C. Harrison and Dr. H. Streit.

No. 126.—"Peas and the Pea-Weevil" by C. A. Zavitz and W. Lochhead.

No. 127.—"Poultry and Poultry Raising" by W. R. Graham.

The buildings erected or completed during the year are the following: the Massey Hall and Library,—a fine brick building furnishing a students' hall, a large reading-room, a newspaper room, a stack-room for 80,000 volumes, a librarian's room, two seminary rooms, and six living rooms for Fellows; the Biological Building,—a large, plain brick structure containing a fair-sized museum, class-rooms for the Physical and Biological Departments, laboratories for general physics and soil physics, and for the different branches of study and investigation in biology—in botany, zoology, entomology, and plant and animal physiology—all well furnished and suitably equipped for instruction and practical work; a fine Live Stock Pavilion for studying and judging horses, cattle, sheep, and swine,—circular in form, 73 feet in diameter, with galleried seats around the wall and ample space in the centre for the animals brought in to be examined and judged: and a coal house, constructed underground beside the boiler house and arranged so that cars of coal can be run over it and the coal dropped through trap doors in a water-tight, cement roof.

Short Courses.

Two short courses were arranged for in the fall of 1901,—one in Live Stock and Grain Judging, to commence on January 8th, 1902, and last for two weeks; and another in Poultry Raising, to commence on January 10th and last four weeks.

No fees were charged for these courses and no examinations were required either at the beginning or at the end, the object being to assist farmers, young and old, who cannot spare the time to attend College in the usual way.

The instruction in both courses was given by our own professors, assisted by the Minister of Agriculture and a few other leading stockmen and poultrymen from different parts of the Province.

The attendance of students in the Poultry Course was 28,—all that we could handle; and the number in the stock-judging course was 220,—

110 more than we could accommodate in our Live Stock Class-room ; so we had to divide the class and repeat the course.

The classes in both courses were composed chiefly of young men; but in the Stock Judging Course there was a considerable number of men over fifty years of age. They were all very much interested in the work ; and the short courses of 1902 were an undoubted success from beginning to end.

Students in Attendance in 1902.

The total number of students registered for work at the College in 1902, was 290 in the General Course, 109 in the Dairy Courses, 25 Specialists, 220 in the Short Course in Stock and Grain Judging, 28 in the Short Course in Poultry Raising, and 96 in the Special Course in Domestic Science,—making a net total of 768 in all courses.

The rooms in the College Residence are reserved, so far as they may be required for Ontario students in the General Course. Ontario students pay $20 a year tuition fee, unless they have been nominated by County Councils to attend as county representatives, in which case they are admitted without payment of fees. A student from any place outside of the Province pays $50 a year tuition fee.

Analysis of College Roll (General Course, 1902.)

1. From Ontario.

Brant	9	Kent	1	Prescott	2
Bruce	7	Lambton	5	Prince Edward	3
Carleton	5	Lanark	4	Rainy River	1
Dufferin	9	Leeds	3	Renfrew	2
Dundas	6	Lennox	2	Russell	3
Durham	3	Lincoln	9	Simcoe	9
Elgin	10	Middlesex	4	Stormont	2
Essex	3	Muskoka	1	Victoria	1
Frontenac	1	Norfolk	2	Waterloo	5
Grenville	2	Northumberland	2	Welland	2
Glengarry	2	Ontario	6	Wellington	11
Grey	7	Oxford	6	Wentworth	12
Halton	4	Parry Sound	1	York	13
Hastings	7	Peel	2	Toronto	14
Huron	8	Perth	5		216

From other Provinces of the Dominion.

British Columbia	2	Nova Scotia	9	Assiniboia	2
Manitoba	2	Prince Edward Island	1		—
New Brunswick	6	Quebec	13		35

From other Countries.

England	7	United States	4	Sweden	1
Jamaica	5	Argentine Republic	17	Uruguay	1
Scotland	1	Asia Minor	1		—
Mauritius	1	India	1		39

Total in General Course 290
Total in General Course and Dairy Courses 399

Ages and Religious Denominations.

The limits of age of students in the General Course, 1902, were nearly the same as in 1901, ranging from 16 to 38 years. The average was 20.

The religious denominations were represented as follows in 1902:

General Course,—91 Presbyterians, 85 Methodists, 48 Episcopalians, 23 Roman Catholics, 18 Baptists, 4 Congregationalists, 4 Disciples, 3 United Brethren, 2 Christadelphians, 2 Friends, 2 Lutherans, 2 Mennonites, 2 New Jerusalemites, 1 Christian Association, 1 Evangelical Association, 1 Greek Orthodox, 1 Plymouth Brother.—290.

Dairy Courses.—33 Methodists, 33 Presbyterians, 14 Episcopalians, 14 Roman Catholics, 5 Baptists, 5 Congregationalists, 2 Christians, 1 Christadelphian, 1 Disciple, and 1 United Brethren.—109.

Counties Represented in 1902.

It will be noticed in the College Roll that 44 Ontario counties and districts were represented in the General Course in 1902. There were 13 from York, 12 from Wentworth, 11 from Wellington, 10 from Elgin, 9 each from Brant, Dufferin, Lincoln, and Simcoe, 8 from Huron, 7 each from Bruce, Grey, and Hastings, 6 each from Dundas, Ontario, and Oxford, 5 each from Carleton, Lambton, Perth, and Waterloo, and smaller numbers from other counties.

County Nominations.

By Legislative enactment, each county council of the Province has power to send one student to the College free of tuition. Of those on the roll in 1902, 66 were nominated by county councils, and hence were exempt from the payment of tuition fees. The counties and districts which exercised the power of nomination during the year (44 in number), were the following: Addington, Algoma, Brant, Bruce, Carleton, Dufferin, Dundas, Durham, Elgin, Essex, Frontenac, Glengarry, Grenville, Grey, Halton, Hastings, Huron, Kent, Lambton, Lanark, Leeds, Lennox, Lincoln, Middlesex, Norfolk, Northumberland, Ontario, Oxford, Parry Sound, Peel, Perth, Peterborough, Prescott, Prince Edward, Renfrew, Russell, Simcoe, Stormont, Victoria, Waterloo, Welland, Wellington, Wentworth, and York.

Our Courses of Study.

About two years ago there were some criticisms of our courses of study by a couple of writers in one of our agricultural journals and by a friend or two who spoke to me about the matter, suggesting or maintaining—

One, that an Agricultural College should confine its attention, exclusively or almost exclusively, to short and strictly practical courses in agriculture, dairying, etc., endeavoring to teach the leading principles of soil physics, agricultural chemistry, economic botany, agricultural and dairy bacteriology, agricultural and horticultural entomology, and general veterinary practice,—without any preliminary study of the fundamental laws and principles of physics, chemistry, etc., as a preparation for the application of these principles to various practical purposes, an introductory talk or two on any science being quite sufficient to prepare agricultural students for lectures on the applications of that science to agriculture in one or other of its various branches.

Another, that a two years' course, as we have it at Guelph, for work and life on the farm, is not too long nor too scientific, but that less time

should be spent on the details of certain branches, such as geology, zoology, and veterinary anatomy and materia medica, in order to leave more time for such practical subjects as agriculture, horticulture, live stock, dairy husbandry, and horse judging and breeding.

A third, that the two years' course is all right, and should be left as it is, but that it is a mistake to require mathematics, English, and French or German, of those who take the four years' course for the B.S.A. degree.

Now, as these criticisms were honestly made by well-disposed people, I feel that as President of the College I should state briefly our reasons for prescribing the courses of study which we now offer, and refusing to make radical changes.

In our last circular, the reader will see that we have

I. A Two Years' Course,—known as the Associate Course, leading to the Associate Diploma.

Intended specially for work and life on the farm.

This Course includes lectures, laboratory work, and manual labor. The subjects embraced in the course are—

English,—grammar, composition, and selections of literature.

Economics,—a short, elementary course.

Mathematics,—arithmetic, mensuration, mechanics, and book-keeping.

Natural Science,—physics, chemistry, geology, botany, zoology, entomology, and bacteriology.

Veterinary Science,—a short course, with emphasis on "practical horse."

Agriculture,—Agronomy and animal husbandry, with emphasis and a good deal of time.

Dairying,—milk-testing and butter-making, with less attention to cheese-making.

Horticulture,—vegetables, fruit, flowers, and landscape gardening.

Forestry,—a short, popular course.

II. A Three Years' Course, leading to a Specialist Certificate in Agriculture or Horticulture.

For Associates who reach a specified rank in English, agricultural physics, agricultural chemistry, economic botany, economic entomology, agriculture, horticulture, and dairying, and wish to specialize for a year in the theory and practice of Agriculture or Horticulture.

III. A Four Years' Course, leading to the B.S.A. degree. For Associates who

(1) have passed the Provincial University Matriculation Examination.

(2) have taken rank in the Associate Course satisfactory to the College staff, say, 50 per cent. of the marks in English and 60 per cent. in general proficiency.

(3) wish to obtain the B. S. A. degree.

A third year, to study French or German, acquire greater proficiency in the use of English, and get a broader and deeper knowledge of the sciences relating to agriculture.

A fourth year, devoted to English, French or German, and one of the following options: Agriculture; Dairying; Horticulture; Biology; Bacteriology; Physics; and Chemistry.

IV. Short courses—

(1) A two weeks' course in Live Stock and Grain Judging.

(2) A three weeks' course in Butter-making.

(3) A four weeks' course in Poultry Raising.

(4) A three months' course in Dairying,—Milk-testing, Butter-making, and Cheese-making.
(5) Practical courses of any length at any time in Home Dairy work.

Note 1.

Our aim is to make the Two Years' Course thoroughly practical, in the true sense,—not by proceeding at once, as suggested by one of our critics, to use terms and apply principles which have not been learned, but by laying in the first year as simply and concisely as possible a solid foundation of scientific principles, and in the second year applying these principles to the solution of problems which arise in practice on the farm.

We spend some time on English in this course, not from choice, but because the early education of many of our best boys has been neglected, and we wish, if possible, to fit them for taking their place in the affairs of Church and State as well as for doing better work on the farms of the Province.

We have from ninety to a hundred boys a year entering for two years or a longer period; and while this is so, we think it would be a great mistake to substitute for our well established Two Years' Course a short, so-called practical course such as that proposed by our critic, proceeding at once to give lectures on agricultural chemistry, farm botany, dairy bacteriology, and other subjects, with the most meagre and fragmentary knowledge of scientific principles to build upon. Such a short course is, no doubt, the best thing for a College that cannot get any considerable number of students for longer and more thorough courses, but not for Colleges that have large classes willing to spend the time necessary to do broader-based and better work on the same lines.

Further, if we should adopt the more superficial short course method in the scientific subjects, it would not serve as a foundation for any of the longer courses, in case short course students should (as they often do) return for one of the courses leading to a diploma, certificate, or degree.

Real education, even a strictly practical education, of the kind farmers need to raise them above the level of mere hewers of wood and drawers of water for the other classes, cannot be got in the rush of a short course, however valuable such a course may be for certain persons and specific purposes. Hence we have decided to continue our regular Two Years' Course leading to the Associate Diploma; but we do not hesitate to admit, with one of our critics, that it may be advisable, in this course, to spend less time on technical details in two or three subjects, in order to get the time necessary for broader and more thorough work in some other subjects that have a more direct bearing on a farmer's every-day duties in after life.

Note 2.

Most of our students, in fact the great majority, take the Two Years' Course and return to the farm; and we have raised the bars fairly high—requiring Provincial University Matriculation, mathematics, English, French, German, etc.—at the entrance to the two additional years required for the B. S. A. degree, in order that students may not be diverted from the farm in the hope of positions of a professional or semi-professional character, as would be the case if the additional work required for a degree in agriculture were made too easy.

The Two Years' Course, leading to an Associate Diploma, is thoroughly practical and not too difficult. The Four Years' Course, leading to the B. S. A. degree, is also practical, but is guarded by higher entrance requirements and made so difficult that none but a few of the best Associates are

allowed to undertake the two years' additional work prescribed under this head.

It will be noticed that the Short Courses which we offer are all of such a character that they can be pursued without much if any preliminary scientific training. Hence they are not open to the objection which may properly be urged against short courses that involve a knowledge of the fundamental principles of physics, chemistry, botany, bacteriology, and other scientific subjects,—a knowledge required but not furnished either before or during the course.

Department Reports.

The members of our staff nearly all perform the double functions of instructors and investigators, teaching and doing more or less original work; and my practice has been to present in a few words the substance of the results obtained from the experimental work in each department; but this year, being hard pressed for time on account of a multiplicity of duties, I must deny myself the pleasure of doing so, and refer the reader direct to the different reports which follow under sixteen heads.

The Macdonald Buildings.

As many questions are being asked about the Macdonald Buildings and the course or courses of study which we propose to offer to women who may come here for Household Science or other subjects, I should, I presume, devote a paragraph to the subject.

The site for the Macdonald Buildings is a high, dry, and beautifully located plot of about twelve acres immediately north of the College Campus, from which it is separated by a public road, along which the Guelph Street Railway runs, forming a loop round the College grounds. From all parts of this beautiful site there are splendid views of the City of Guelph, of the country away southwest, and for four or five miles over the valley traversed by the Grand Trunk in the northeast. There will also be a good view of the College grounds as soon as a little pruning of trees is done.

As already stated, two buildings will be erected on this site during the coming summer,—the Macdonald Institute, for instruction and practical training in Nature Study, Manual Training, and Household Science,—including cooking, plain sewing and mending, dressmaking, millinery, laundry work, and general housekeeping; and close by it a large building to be known as Macdonald Hall, which will be a Residence for 100 women, something similar to our boys' Residence, but better planned and furnished.

About a year ago, Sir W. C. Macdonald, of Montreal, gave us $125,000 for the erection and furnishing of these buildings; and we intended to proceed with the work at once ; but we had not gone far till we discovered that the cost of building had increased to such an extent that even $125,000 was not sufficient to provide the buildings that seemed necessary to accomplish the objects for which the money had been given. We drew plan after plan, making changes, alterations, and reductions, till at length we gave up in despair and had to lay the whole matter before Sir William,—when, to our surprise and delight, he at once added $50,000 to his magnificent bequest of a year ago, making a total of $175,000. The plans were then completed, the contracts for the buildings were let, and the work will proceed the moment the frost is out of the ground.

Water mains and fire hydrants have to be put in; an electric line has to be taken over from the College; the ground has to be graded, roads made,

and cement walks laid—many, very many things have to be done, and the time is very short; but we hope to have the buildings furnished and ready for use by the 13th of September next.

We are now working on the courses of study and intend to issue an announcement early in the summer, giving such information as intending applicants for admission may require. All I can say at present is that we shall offer a fixed course for teachers and two or three courses for farmers' daughters, allowing considerable latitude in the choice of subjects, as Sir William Macdonald wishes us to do all that, under the circumstances, can be done to assist young women from the farms of the country in their efforts to master the difficult but all important art of home-making.

Farmers' Excursions.

Last summer we had rather more than the usual number of excursionists under the auspices of the Farmers' Institutes,—something over 30,000. Most of them were farmers, and their wives, and sons, and daughters. They had been here before; and they came again, not so much for an outing or mere amusement, as in the hope of learning something that would assist them in the management of their own farms.

Class-room Work.

The class-room work in the different departments of the College course has gone on as usual. A fair proportion of first and second year students gained a respectable standing in our College examinations; but the percentage of failures is still large, resulting in some cases from idleness, but in most instances from a lack of early training in the elementary branches of an English education.

The fourth year examinations were conducted by examiners appointed by the Senate of the University of Toronto; and those of the first, second, and third years by the professors and instructors of the College.

Bachelors of the Science of Agriculture.

The examinations for the degree of B. S. A. were held in the month of May, and the successful candidates received their degrees at the commencement exercises of the University in June. The list was as follows :

Black, W. J. ..... Stanton, Dufferin, Ont.
Carson, W. J. ..... Vernon, Russell, Ont.
Christie, G. I. ..... Winchester, Dundas, Ont.
Hallman, E. C. ..... Washington, Waterloo, Ont.
Jacobs, F. S. ..... Minesing, Simcoe, Ont.
Moorhouse, L. A. ..... Cairo, Lambton, Ont.
Murray, J. ..... Avening, Simcoe, Ont.
*Waters, B. J. ..... Ivan, Middlesex, Ont.

*To take supplemental examination in Bacteriology.

Recipients of Associate Diplomas.

Barber, T. C. ..... Yorkton, Assa.
Barton, H. ..... Vankleek Hill, Prescott, Ont.
Bray, C. I. ..... Kleinburg, York, Ont.
Buchanan, D. ..... Florence, Lambton, Ont.

Bustamante, R. S. . . . . Jujuy, Argentine Republic.
Clarkson, F. L. . . . . Sweaborg, Oxford, Ont.
Coglon, M. F. . . . . Bath, Lennox, Ont.
Colter, G. L . . . . . Mouth of Keswick, N. B.
De Coriolis, E. G. . . . . Forest Side, Mauritius.
Dewar, W. R. . . . . Fruitland, Wentworth, Ont.
Downing, R. J. . . . . Fenaghvale, Prescott, Ont.
Duff, W. E . . . . . Stirton, Wellington, Ont.
Dysart, A. A. . . . . Cocagne, N. B.
Elliott, G. W. . . . . Cathcart, Brant, Ont.
Fulmer, H. L. . . . . Ruthven, Essex, Ont.
Gunn, R. E. . . . . Toronto, Ont.
Hamilton, W. . . . . Ravenshoe, York, Ont.
Henderson, T. B. R. . . . . Rockton, Wentworth, Ont.
Houser, H. W. . . . . Campden, Lincoln, Ont.
Irvine, A. . . . . Habermehl, Grey, Ont.
Johnston, J. . . . . Fingal, Elgin, Ont.
Laird, J. O. . . . . Blenheim, Kent, Ont.
Metcalfe, I. F. . . . . Burford, Brant, Ont.
McCallum, J. M. . . . . Shakespeare, Perth, Ont.
Morton, W . . . . . Bethany, Durham, Ont.
McNaughton, F. B. . . . . Balderson, Lanark, Ont.
Panelo, J. . . . . Buenos Aires, Argentine Republic.
Paul, R. H. . . . . Bath, Lennox, Ont.
Peltzer, J. . . . . Buenos Aires, Argentine Republic.
Readey, J. C. . . . . Rosetta, Lanark, Ont.
Reynolds, R. H. . . . . Scarboro' Junction, York, Ont.
Rothwell G. B. . . . . Ottawa, Carleton, Ont.
Shearer, F. J. . . . . Vittoria, Norfolk, Ont.
Smith, R. S. . . . . Toronto, Ont.
Stauffer, G. A. . . . . Ringwood, York, Ont.
Strachan, C. L. . . . . McKenzie, Man.
Thom, C. C. . . . . Elma, Dundas, Ont.
Zavitz, C. J. . . . . Fork's Road, Welland, Ont.

First-class Men.

The work of the College is divided into departments, and all candidates who obtain an aggregate of seventy-five per cent. of the marks allotted to the subjects in any department are ranked as first-class men in that department. The following list contains the names of those who gained a first-class rank in the different departments at the examinations in 1902, arranged alphabetically :

First Year.

Albright, W. D., Beamsville, Ont., in four departments,—English and Mathematics; Physical Science; Biological Science; Agriculture.
Cameron, R. R., Ailsa Craig, Ont., in one department,—English and Mathematics.
Deachman, R. J., Gorrie, Ont., in two departments,—English and Mathematics; Biological Science.
Eddy, E. D., Scotland, Ont., in one department,—English and Mathematics.
Esmond, C. W., Blessington, Ont., in one department,—English and Mathematics.

Groh, H., Preston, Ont., in one department,—Biological Science.
Howitt, J. E., Guelph, Ont., in one department,—Biological Science.
McDonald, D. J., Crawford, Ont., in one department,—English and Mathematics.
McKillican, W. C., Vankleek Hill, Ont., in three departments,—English and Mathematis; Physical Science; Biological Science.
Pearse, S. M., Iona, Ont., in three departments,—English and Mathematics; Physical Science; Biological Science.
Reid, F. H., Georgetown, Ont., in three departments,—English and Mathematics; Physical Science; Biological Science.

SECOND YEAR.

Barton H., Vankleek Hill, Ont., in three departments,—Physical Science; Biological Science; Agriculture.
Dewar, W. R., Fruitland, Ont., in three departments,—English and Mathematics; Physical Science; Biological Science.
Fulmer, H. L., Ruthven, Ont., in two departments,—Physical Science; Biological Science.
Houser, H. W., Campden, Ont., in four departments,—English and Mathematics; Physical Science; Biological Science; Agriculture.
Laird, J. O., Blenheim, Ont., in two departments,—English and Mathematics; Biological Science.
McCallum, J. M., Shakespeare, Ont., in four departments,—English and Mathematics; Physical Science; Biological Science; Agriculture.
Readey, J. C., Rosetta, Ont., in four departments,—English and Mathematics; Physical Science; Biological Science; Agriculture.
Thom, C. C., Elma, Ont., in one department,—Biological Science.

SCHOLARSHIPS.

Scholarships of $20 each in money were awarded for groups of subjects in first year work, as follows :

Highest standing, with a minimum of forty per cent. of the marks for each subject, and an aggregate of seventy-five per cent. of the total number of marks allotted to the subjects in the group—

I. English, Mathematics, Book-keeping, and Drawing,—S. M. Pearce.
II. Physics, Chemistry, and Geology,—F. H. Reed.
III. Botany, Zoology, and Horticulture,—W. C. McKillican.
IV. Agriculture, Dairying, Poultry, Apiculture, and Veterinary Science, —W. D. Albright.

Prizes.

Prizes were given as follows :

Essay on "Addison, Macaulay, and Carlyle as writers of English Prose". —$10 in books to H. W. Houser, Campden, Lincoln, Ont.

First place in general proficiency on first and second year, theory and practice,—$10 in books to H. W. Houser, Campden, Lincoln, Ont.

Governor-General's Silver Medal.

Highest in general proficiency, second year, 1901-1902.—H. W. Houser, Campden, Lincoln, Ont.

THANKS AND FURTHER REQUESTS.

I wish most sincerely to thank the Minister of Agriculture, the other members of the Government, and the members of the Legislature for the lib-

eral contributions which they have recently made for buildings, laboratory equipment and the employment of an efficient staff at the Ontario Agricultural College. The liberality has been marked; and the results are, I think, satisfactory to all concerned. We are doing much more and better work than in the past; the attendance of students is increasing; and the farmers, Liberal and Conservative alike, are beginning to look upon the College as distinctively and peculiarly their own institution—a place where their wants are always considered, and their questions promptly answered. They look to the College for help and leadership at every turn. Their rapidly growing confidence and support are a manifest source of strength to the College; and we can truthfully say that the liberality of the Legislature has not been in vain.

So far, well, and we are thankful; but the motto in our coat of arms is *nulla dies sine linea,* no day without a line,—progress. Always pushing ahead. No time even to congratulate ourselves. When an institution ceases to grow and develop, dry rot sets in. Hence our unyielding determination to keep forging ahead.

We now have three good laboratories, fairly well equipped,—the physical, chemical, and biological laboratories, although the chemical laboratory is not large enough for the students now in attendance, to say nothing of the extra room that will be required when lady students are admitted next fall. We have also a well equipped horticultural department; but we are much in need of a large and well appointed bacteriological laboratory and an isolation stable, with the equipment necessary for the instruction of students in the General Course, special instruction and laboratory practice for students in the Dairy Course, more advanced work for specialists in the third and fourth years of the B.S.A. Course, and an endless amount of investigation of matters pertaining to tuberculosis, anthrax, hog cholera, glanders, roup, foul brood, and other diseases of birds, bees, and farm stock.

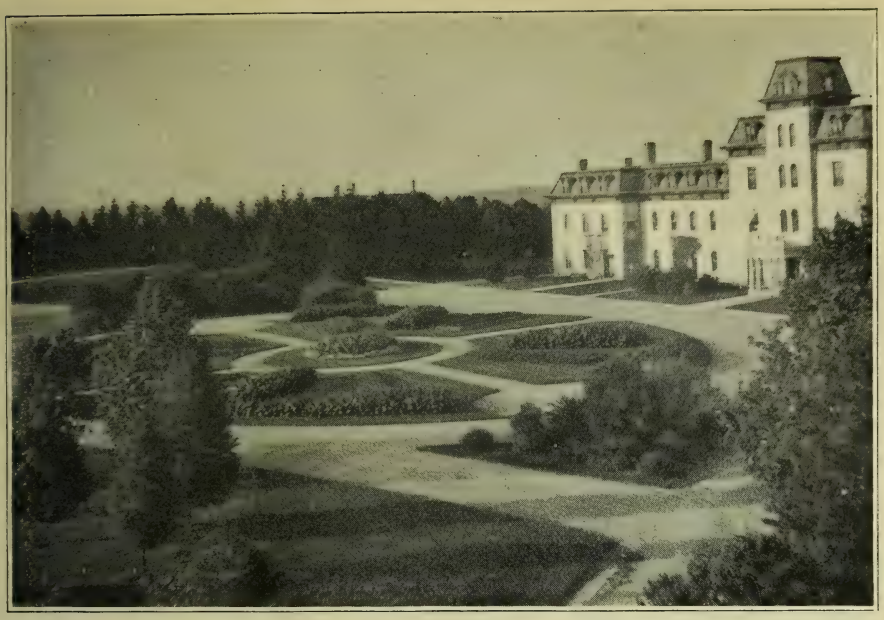
We also need a new carpenter shop and a large shed with electric power arranged so that farm implements and machinery can be put in motion, operated, examined, and compared by students with a competent instructor in the winter months,—as is done at the Industrial Fair during the progress of the Exhibition.

These are our most urgent needs, and I submit them in the hope that they will receive favorable consideration from the Government and the new Legislature.

The financial statement on maintenance account as prepared by the College Bursar, in accordance with the estimates for 1902, will be found at the end of this volume.

Ontario Agricultural College,
Guelph, December 31st, 1902.

JAMES MILLS,
President.



Portion of Main College Building.

Massey Hall and Library.

Annual and Perennial Flower Borders.
(See page 77.)

A Student's Collection of House Plants.
(See page 77.)

PART II.

DEAN OF RESIDENCE AND INSTRUCTOR IN ENGLISH.

To the President of the Ontario Agricultural College:

Sir,—I have much pleasure in submitting a brief report of my first year's work as Dean of Residence and Instructor in English.

In my capacity as Dean of Residence, it has been my duty to preside in the College dining-hall, superintend evening study, inspect the College furniture, look after repairs when necessary, and direct students as to duty and conduct.

Considering the crowded condition of the dining-hall, I think the order and decorum maintained there is good. The hall has a seating capacity of 180; and even that is far from adequate for the accommodation of the increased number of students in attendance at the present time.

The students, with but few exceptions, are strongly disposed to observe the rules and regulations regarding the study hour. The campus, gymnasium, and outside work furnish a vent by means of which an escape is afforded to the superfluous energy of youth. To these, and to the thoughtfulness of the students themselves, may be attributed, in large measure, the quiet which prevails during the study-hour. As the term wears away, I notice a marked improvement in the methods of study. Time-tables are made out, work is planned, and system prevails in the study-room. Many who at the beginning of the term were unable to read and think continuously during the study-hour, show marked signs of development in the power of application and concentration.

My class-room work first comprised lectures in English, Grammar, Composition, Mathematics, Drawing and Bookkeeping, but, with your consent, a change was made by which Prof. Reynolds took the Mathematics and Drawing, and gave me the English of the Second Year. So that now my work is largely English. In this, I have endeavored to give the students a working knowledge of the subject. The Grammar is studied with a view to learning the correct form of words, with their varied inflections, and the general laws and idioms of the language. In English Literature, both poetry and prose are taught with a view to enlarging the student's field of thought, increasing his vocabulary and means of expression, acquainting him with a few of the standard writers of English, and developing in him a love of good literature. In Composition and Rhetoric, my object has been to give the student such training as will enable him to express his thoughts in a clear, correct, and forcible manner. This has been done by dealing first with the form and structure of sentences, followed by the combining of sentences into paragraphs, and paragraphs into a connected whole. The students have had practice in the planning and writing of compositions on such topics as the following: "The Winter Fat Stock Show," "How to Beautify the Country Home," "Rural Mail Delivery," "New Ontario," "The Advantages of Good Roads in the Country," and "Education for the Farmer." Besides class work, much of my time has been given to personal work with individual students desirous of help in the correction of their compositions.

The course in Bookkeeping comprises commercial forms, business correspondence, and the keeping of farm and other accounts.

In closing, it is scarcely necessary for me to remind you that the residence is in no way adequate for the accommodation of the large number of students now attending the College.

I am respectfully,

Your obedient servant,

W. J. RUTHERFORD.

PART III.

PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH.

To the President of the Ontario Agricultural College:

Sir,—I have the honor to present herewith my Eight Annual Report.

The Work in English.

English Literature. With regard to the work in English, it is gratifying to note that, notwithstanding the constantly increasing pressure from other subjects on the curriculum that are more immediately utilitarian, the subject of English continues to receive from the students no less attention than in former years, but rather more. It is a compliment to the ambition and the intelligence of our students to say that they exhibit an interest which is not perfunctory, in the classics of English literature. Shakespeare, Milton, Wordsworth, Tennyson, and Carlyle, Scott, Eliot, Irving, are to them not mere names, but more or less intimate acquaintances. At the same time, however, it has been found expedient to lessen the amount of work required of the classes in English Literature, in order to give an opportunity to emphasize the other branches of English.

English Composition, theoretical and practical, receives more attention in class-work than formerly. The usefulness of this branch of the work is, of course, measured and limited by the amount of time that can be spent by the students in the writing of composition and essays. We have two methods for considering this practical work in English. The papers written by students, on subjects chosen or assigned, are read by the writers in class, and criticized as to style and method by the class or the teacher. Or, the papers when written are handed to the teacher to be examined, marked and valued; they are then handed back, and the principal forms of error in composition that have occurred in these papers are written on the board for discussion in class. Of these methods, the former allows more work to be covered in class, and, therefore, has a necessary place; the latter method, however, is more effective in inculcating carefulness and correctness in composition. The progress in this branch is most encouraging. Mr. Rutherford, the Dean of Residence, has charge of the First and Second Year work in English Literature and Composition.

Public Speaking. Under the able direction of Prof. Cumming, this part of the work is making most satisfactory progress. With the classes giving instruction and practice, and with the opportunities afforded in the seminaries and in the Literary Society, every student now has the means, if he will, of advancing beyond the tyro stage in platform speaking.

Instruction in Mathematics and Physics.

Decimals, the Metric System, and Mensuration. In a course of two periods a week, with some afternoon periods, the above subjects are given to the First Year. The instruction on decimals comprises a thorough course in decimal notation, adding, multiplying, and dividing of decimals, calculating percentages by the decimal notation, with some work on annuities. With regard to the decimal notation proper, I am trying to substitute it in all problems, so far as practicable, for the fractional notation, which is clumsy, inconvenient, and out-of-date.

The Metric System of weights and measures is at the present time a proper subject of study for all schools and colleges. The displacing of our present system of measuring, weighing, and calculating by the decimal or metric system, is only a matter of time. All intelligent persons will welcome an opportunity to understand the new and improved system.

Mensuration, or the science of measuring, is presented only in its simplest and most practical form. Rules and practice in measuring lumber, bins, cisterns, silo, and land areas, calculating the amount of material required in building, and similar questions comprise the greater part of the work in this subject. In all of these—the decimal system, metric system, and mensuration—practical work in the laboratory is part of the course.

The Physical Properties of Woods is a new subject, born of the agitation for increased instruction in Forestry. As yet, we are taking up the subject only in a small way, partly for its own sake and partly as an exercise in mensuration. We have obtained samples of Canadian building and furniture woods. These samples are in board form, being planed and squared. They are weighed in grams, and the weight, with the name of the wood, stamped on each sample. The students are required to measure the dimensions of each piece, and calculate the cubic contents and the specific gravity. In addition, they note the color, grain, and texture of each wood. This, of course, is a mere beginning in Timber Physics, but even this small amount of knowledge gained is worth the getting.

Mechanics is principally a laboratory subject, in which the First Year investigate for themselves, the simple and common forms of mechanical appliances.

Surveying is a subject for the fall term of the Second Year, and consists of a six weeks' course of lectures, of field work in measuring land areas of different shapes, and of laboratory work in plotting on paper the results of the field work. Following this is a course in General Physics, so far as it explains the movements of water and air in the soil, and afterwards a course in Soil Physics in its more practical aspects.

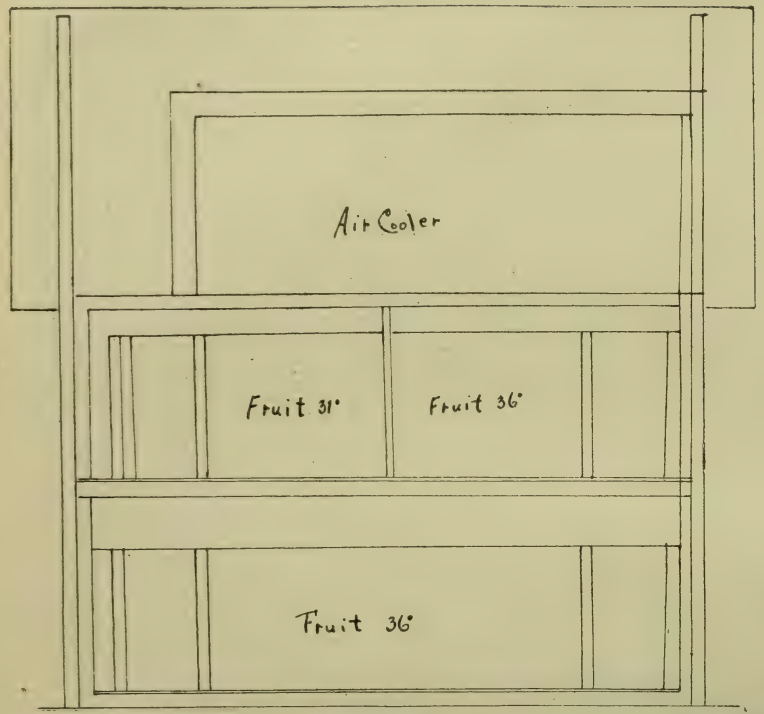
In order to supplement the rather defective attainments of our students in Mathematics, a course in Algebra and Euclid is given in the Third Year. The Physics for the graduate course begins with Meteorology, which is followed by Cold-storage in the Third Year, and Soil Physics in the Fourth Year.

A large number of lectures are implied in the various parts of the work in English, Mathematics, and Physics. The preparation and delivery of these lectures and the supervision of the laboratory work in the four years, form my College duties.

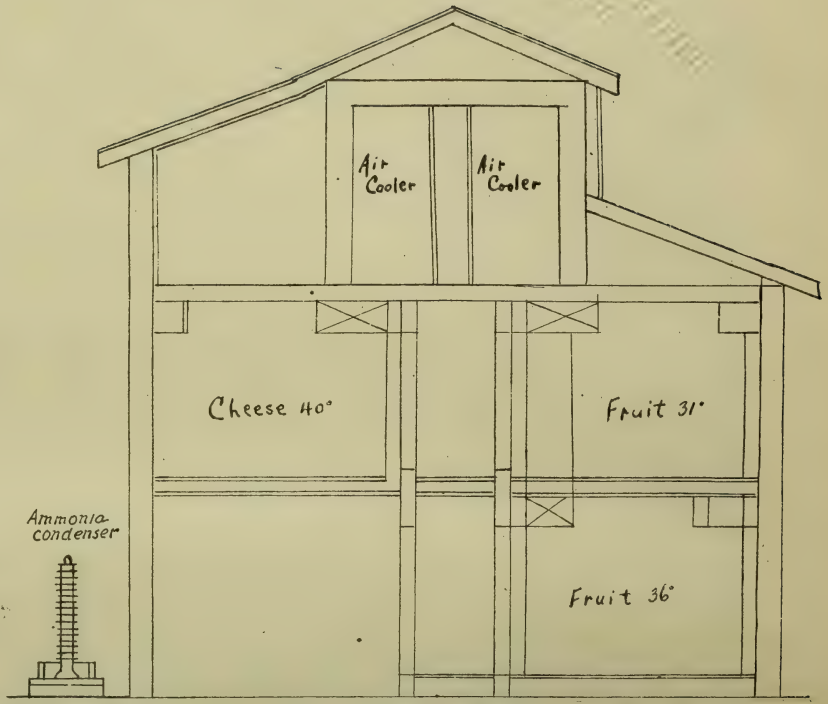
The correspondence of this department, while not large, is constantly growing in bulk and importance. During the past year, a large number of questions have been received and replied to concerning cultivation of farm crops, qualities of soil samples submitted for examination, farm water-supply, ventilation, and cold-storage; and I take pleasure in inviting correspondence with farmers on any of these subjects.

Early in the year, Bulletin 119, on Ventilation of Farm Stables and Dwellings, was prepared by the writer and published by the Department of Agriculture. Later, Bulletin 123, on the Cold-storage of Fruit, was prepared jointly by myself and Prof. Hutt, and published also. I had the honor also, with the rest of the College staff, of being invited to take part in the preparation of a bulletin on Nature Study, or Stories in Agriculture —Bulletin 124—which has just been published.

In all of the above work, and in the investigation conducted by this



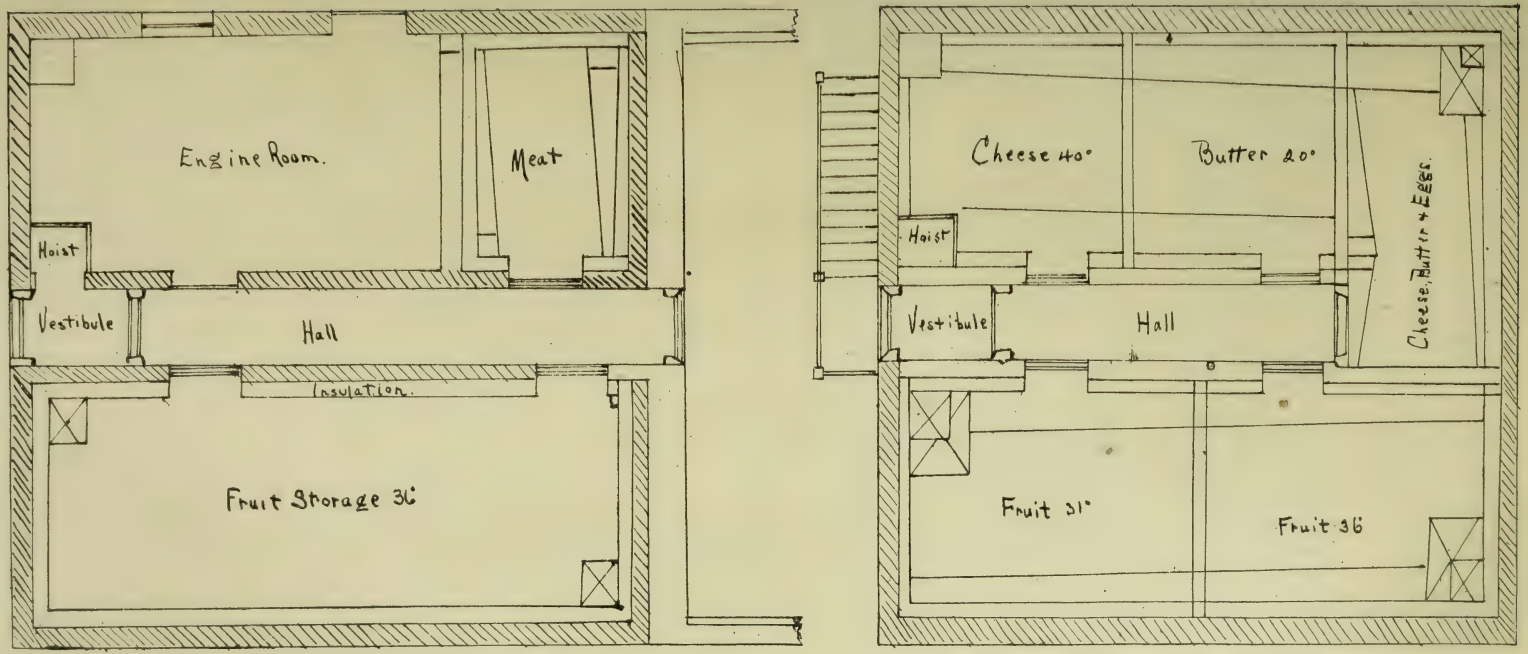
Side elevation.



End elevation.

Scale.—Eight feet to one inch.

PLANS OF COLD STORAGE BUILDING, ONTARIO AGRICULTURAL COLLEGE.



Ground floor. Scale.—Eight feet to one inch. First floor.

PLANS OF COLD STORAGE BUILDING, ONTARIO AGRICULTURAL COLLEGE.

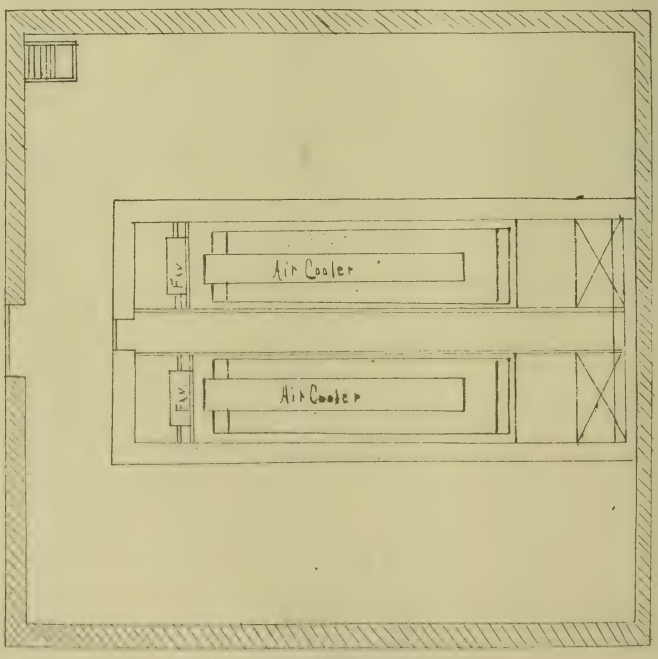
department, I had the able assistance of Mr. G. B. McCalla, Fellow in Physics. Mr. McCalla's work has been characterized by ability and faithful attention to details.

The Cold Storage Building.

A new Cold-Storage system is being installed at the College, principally for the purpose of experimenting on the storage of different kinds of farm produce. There are six experimental chambers in the building—three for dairy products and eggs—in which different temperatures will be maintained as required; two for fruit to be held at different temperatures; and one for the meat and poultry in which the temperature can be varied from time to time.

The building will be cooled mechanically by the method of air circulation. By a powerful compression pump, ammonia vapor is compressed and liquefied, and then the liquid ammonia is allowed to pass into coils of pipes where the pressure is reduced. In these pipes, the liquid ammonia evaporates and by its evaporation refrigerates everything in the vicinity of the expansion pipes. The expansion pipes are situated in an air chamber, and a fan drives the air over the pipes, thence through ducts into the rooms to be cooled, and then back again to the cooler.

In order to prevent indiscriminate mixing of air from cheese-rooms, butter-rooms, and fruit and vegetable-rooms, two fans and two coolers will be in operation, one for cheese and butter and the other for fruit and vegetables; and the circulating air of each system will be kept entirely separate from that of the other system.



Second Floor of Cold Storage Building.

In addition to the six experimental chambers, the building contains one room 26 x 10 for College use, and is connected with the College by means of a door, which has been cut through the wall into the store-room. There is also in the building the engine-room, containing the engine and

compressor for working the fans. The engine-room has been made sufficently large to accommodate an ice-tank for the manufacture of artificial ice, although the tank is not being procured at the present time. The engine is driven by steam supplied from the College boilers.

The insulation of the walls consists :

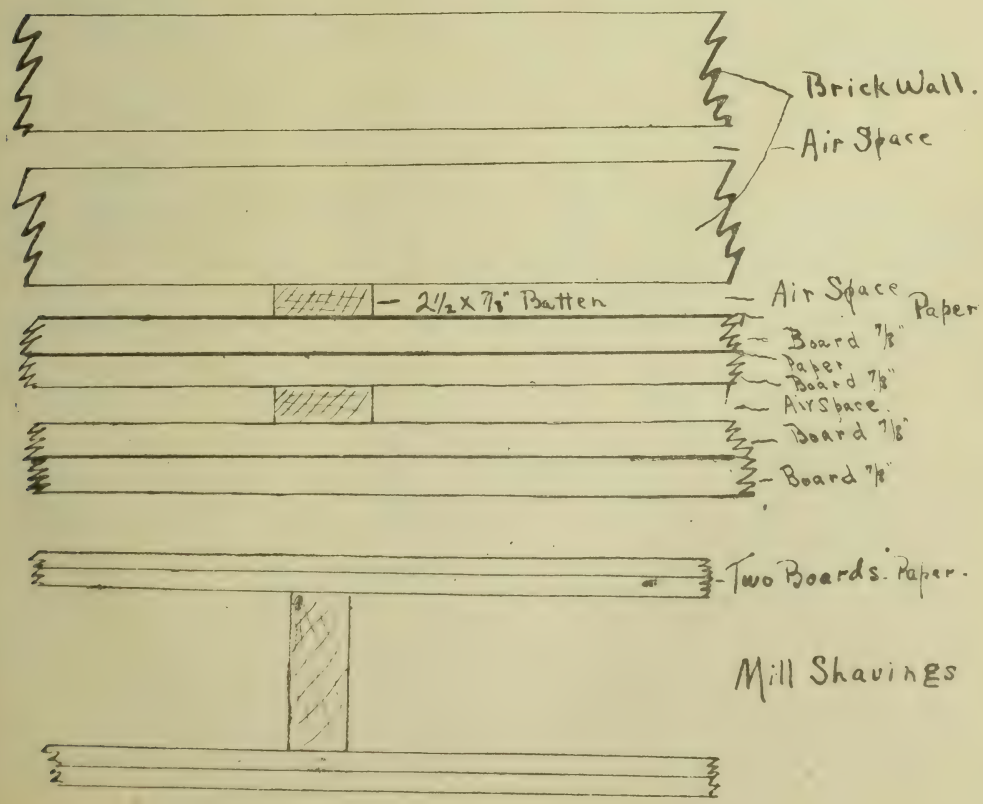
1. Of a hollow brick wall, constructed as follows: Two 4½-inch walls, with a 2½-inch space between. Across this space, at intervals of three feet, a bonding course of brick is laid all round.

2. The two inside faces of the walls are coated with a preparation of cement plaster, making each wall practically air-tight; and the top of each bonding course is also plastered, so that we have secured within the wall a series of dead-air spaces.

3. Next to the wall is strapping placed vertically, and on this is a heavy coating of insulating paper, and then lumber, paper, and lumber, making a second air-space and a course of insulation. Next comes strapping laid vertically and horizontally, in squares, then lumber, paper, and lumber, making another dead-air space with a second course of insulation.

4. The floors are insulated by two thicknesses of lumber and one thickness of paper, above and below the joists, with mill shavings between the joists. This is the style of insulation also around the cooler above the second floor.

For a better understanding of this description, I beg to refer to the accompanying plans.



My last annual report contains a description of the ice-system of cooling a storage-room. It is not to be supposed, merely because we are building a cold-storage to be cooled by a system other than ice, that we, therefore, pronounce ice, as a refrigerant, unsatisfactory or out-of-date. Where only one temperature is required, or where moderate cooling is sufficient, or for short storage, ice is usually cheaper than the mechanical systems, and just as satisfactory. But the fact is, that different products require different temperatures for the best results; for example, apples keep best at a temperature of about 31 degrees, while butter requires for long storage a temperature of 20 degrees or below. These differences of temperature are difficult to obtain in the same building by means of ice, and the lower temperatures are practically impossible. Hence the mechanical systems, although more costly in the outfit and perhaps in the maintenance, are of wider application and of more extended usefulness. Only the ice system is possible in a small business. Also for short and occasional storage, the ice system is quite suitable. But in a large storage business, dealing in various kinds of produce and holding the produce for some length of time, the mechanical system is much to be preferred.

The importance of cold-storage for Ontario cannot be over-estimated. If the markets for these perishable products that Ontario can furnish in such magnificient quantities and excellent quality are to be captured and held in different parts of the world, it can be done only by maintaining unimpaired the quality of the products until they reach their markets. Cold-storage is an aid to this preservation; but its increasing use has drawn attention to other aids, and has given additional emphasis to the fact that only the best products under the best care are worth long storing or shipping. Cold-storage therefore, derives not its least importance, commercially, from the encouragement that it gives to improved methods in producing and handling our perishable food-stuffs.

Results of Experiments in the Cold Storage of Fruit.

(From Bulletin 123.)

1. Apples and pears keep best when wrapped singly in paper, and packed in a shallow box not larger than a bushel. They ship best when, in addition, they are packed in layers with excelsior between.

2. Apples keep better at a temperature of 31 degrees than at a higher temperature. Our experiments do not show what is the best temperature for pears.

3. Cold-storage cannot make bad fruit good; neither can it keep bad fruit from becoming worse. Only good specimens will keep for any length of time in cold-storage, or will pay for storage.

4. For long storage, it pays to select the best fruit and to pack it in the best manner known. The extra labor and the cost of material are more than repaid in the greater quantity and better quality of fruit left at the end of the storage period.

5. Wih apples and pears, at least, and, it seems likely, for most kinds of fruit, the fruit should be picked and stored in advance of dead ripeness. The maturing process goes or more slowly in cold-storage than on the tree or bush.

6. With the two kinds of fruit tried, apples and pears, the medium sizes of fruit kept longer than the largest, all being perfect specimens and picked at the same time. It would, therefore, be an advantage, especially with pears and peaches, to pick the larger specimens first, and leave the smaller to mature later.

7. Fruit, on being removed from cold-storage, should be allowed to warm gradually, and moisture should not be allowed to deposit upon it. But if the wetting cannot be prevented, then the fruit should be spread out and dried as quickly as possible.

8. With all kinds of fruit, there is a time limit beyond which it is unprofitable to hold it in cold-storage, or anywhere else. That limit, for sound fruit, is dead ripeness. Duchess pears can be kept profitably until late in December; Fameuse, or Snow, apples, until March or April. The time limit has to be determined for each kind of fruit.

9. In addition to proper conditions in the storage-room, the most important points are the selection of sound fruit; grading into uniform sizes, one variety only in a case, and careful packing. Therefore, the results of these experiments can be made use of by the family, in preserving fresh fruit for their own use; by the fruit-grower, in securing better prices for good fruit later in the season, in the local markets; and by the shipper, in enabling him to take advantage of the higher prices offered in foreign markets.

Destruction by Lightning in Ontario, 1902.

The investigations carried on last year regarding the amount of damage done by lightning stroke, and the conditions of liability to the stroke, were continued during the past summer.

The reports received are tabulated below.

Buildings Struck and Burned, Wholly or Partially.

Circumstances.	Dwellings.		Churches.		Barns.	Stables.	Town Bldgs.	Loss.
	Brick.	Frame.	Brick.	Frame.				
Isolated	4	5	.....	.....	30	2	1	$7,640
Near Trees	1	.....	.....	.....	5	.....	1	3,700
Near other buildings	.....	2	3	.....	4	.....	.....	4,100
	5	7	3	.....	39	2	2	$15,440

It will be seen that the damage done to buildings by lightning is comparatively small, according to the reports sent in. Last year, about $47,000 worth of damage was reported; but this year, while a great number of buildings were reported to have been struck, the loss was only about one-third that of 1901. Of the 58 buildings struck, 47 were injured only to the amount of $50 each or less, and only 6 to the amount of $1,000 or over.

Only three of the buildings struck were provided with lightning rods. One was not injured; the other two, only slightly.

Of the total number of buildings struck during the summer, the frequency for each kind of building is indicated below in percentage.

Barns, with season's crop, 21; Barns, empty, 46—67. Stables, 4. Dwellings, 20. Churches, 5. Town buildings, 4.

For some reason, probably the peculiarity of the season, the loss of barns after harvest is relatively small. Last year, the percentage of full and empty barns struck was the reverse of the above.

Stock Killed.

Circumstances.		Horses.	Cattle.	Sheep.	Hogs.	Value.
Under Trees.	Oak	.....	2	1	.....	$ 80 00
	Beech	1	.....	.....	.....	75 00
	Basswood	1	.....	.....	.....	200 00
	Spruce	1	.....	.....	.....	150 00
	Maple	.....	1	14	.....	100 00
Not specified		.....	.....	11	.....	75 00
Near fence		4	6	4	.....	700 00
In stable		5	.....	.....	2	750 00
Edge of bush		1	1	.....	.....	165 00
Near barn		.....	2	3	1	185 00
Without shelter		4	10	14	.....	630 00
		17	22	47	3	$3,110 00

These figures correspond in general with the results of last year. Both years' results show that a considerable per cent. of the animals killed were without shelter. This year, the proportion killed near fences is somewhat greater than last year. In every case reported, the fences were either wire ones, or a combination of rail and wire. This fact seems to give point to the question, if the wire fence is not a considerable source of danger. The precaution of connecting each strand of the wire fence to the earth at intervals of, say, 500 feet, is inexpensive, and is practically recommended as a safeguard against loss of stock in the field.

Trees Struck.

Kind and No. of Trees.	Situation.	Nature and extent of damage.
4 Elm	Isolated	3 split; 1 not specified.
1 Elm	In group	Bark peeled.
1 Elm	In forest	Bark peeled.
4 Oak	Isolated	1 completely shattered; 3 bark peeled.
1 Oak	In group	Completely shattered.
1 Maple	Isolated	Bark peeled.
1 Maple	In forest	Splintered.
2 Maple	In group	Destroyed.
1 Ash	Isolated	Bark peeled.
1 Ash	In group	Split.
1 Basswood	In group	Shattered.
1 Basswood	In forest	Top broken off.
1 Hickory	Isolated	Scratched.
1 Poplar	In group	Split.
1 Beech	In forest	Limb taken off.
1 Willow	In group	Splintered.
1 Balsam	In group	Split.
1 Pine	In group	Destroyed.

No particular species is definitely shown to be more liable to lightning stroke than others, although the elm has sustained the most injury during both seasons. On the other hand, the pine, which last year headed the list, has this season reversed its position.

Persons Struck.

No.	Circumstances.	Extent of Injury.	Remarks.
1	In porch of church	Killed	Building slightly injured.
2	Just outside house	Killed	2 children standing a few feet apart.
1	In house, by chimney.	Killed	
1	By window, in house	Injured	

With regard to the Lightning reports, there are two conclusions, deduced from last year's results also, but important enough to bear repetition. First, the value of trees as protectors. Of the 58 buildings reported as struck, only seven were near trees. It is permissible to conclude, that if the remaining 51 had also been near trees, fewer instances of destruction by lightning would have been reported. Although we have had as good chance to obtain reports from towns as from country, only four per cent. of the reports are of town buildings. The practice of planting shade-trees on both sides of streets in towns and villages is becoming prevalent in Ontario. If this practice were as prevalent in rural districts, it is more than probable that much less loss by lightning would occur.

As to the variety of tree it is best to plant, our reports do not show conclusively. A certain character of tree, however, is to be reecommended, —one not too tall and slender, but still with a pointed crown. There is no tree that answers to this description better than the spruce used in shelter-belts. A girdle of these around the farmstead will form shelter against the storm and proptection from lightning stroke. The Canadian maple, the favorite shade-tree in Ontario, while not of the orthodox form as a lightning protector, must, nevertheless, be very serviceable in this respect when grown in sufficient numbers, as in a belt or row. The comparative immunits of town buildings from lightning, where the maple is the principal variety of shade-tree, confirms this statement.

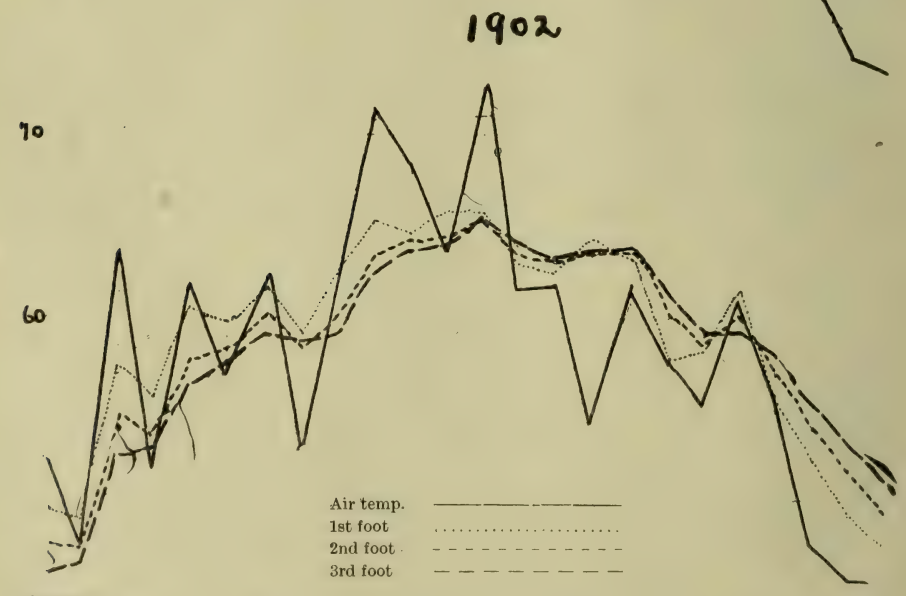
The second conclusion concerns the lightning-rod. Only three rodded buildings were reported struck, and the three received but slight injury. There are, of course, two difficulties in the way of reaching decisive conclusions on this matter. First, the question may be asked, Would the buildings have been struck at all if they had not been rodded? To that question no certain answer can be given. The fact remains, however, that the buildings, being struck, were only slightly damaged. The second difficulty lies in the lack of data regarding the proportion of rodded and unrodded buildings over Ontario. It may be said that the number of rodded buildings struck, viz., three, bears as great a ratio to the total number of rodded buildings in Ontario, as the number of unrodded buildings struck, viz., fifty-five, bears to the total number of unrodded buildings. As yet, we have been unable to secure any data upon this point, and, therefore, cannot discuss the question.

Sub-Soil Temperatures.

For the past two years, a record of the sub-soil temperatures at a depth of one, two and three feet, has been kept during the growing season. A

condensed record of these observations, together with the average air temperature, is given in the following charts.

RECORD OF SUBSOIL TEMPERATURES.



Rainfall—						
1901.....	3.255	1.525	4.065	3.510	2.445	3.367
1902.....	1.674	3.055	6.430	2.180	3.575	2.816

It will be observed, speaking generally, that during the spring and summer months, the first foot is the warmest; but as the fall advances, this is reversed and the third foot retains its heat, as would be expected, longer than the upper layers of soil.

The maximum temperature reached this year, at a depth of one foot,

is about ten degrees lower than that of last season. The difference is particularly noticeable during the months of June and July. It will be seen that, while for these months the average air temperature is not greatly lower than that of last year, the soil temperatures are very much lower. This is accounted for by the much greater rainfall during the months of 1902.

RAINFALL AND TEMPERATURES, DEC. 1ST, 1901, TO DEC. 1ST, 1902.

Month.	Temperatures.				Precipitation.		
	Maximum.		Minimum.		Rain.	Snow.	Total in inches of rain.
	Degrees.	Date.	Degrees.	Date.			
					in.	in.	
December	55.0	14	— 4.0	21 and 22	2.24	8.5	3.09
January	36.8	2 and 3	— 4.5	29		11.5	1.15
February	47.8	27	— 4.0	5	.565	11.5	1.715
March	60.0	30	8.0	18	2.22	.25	2.245
April	76.0	23	25.0	5	2.433		2.433
May	84.0	23	29.0	10	1.674		1.674
June	83.0	16	35.0	9	3.055		3.055
July	89.0	7	44.5	1	6.43		6.43
August	85.0	1	43.5	12	2.18		2.18
September	83.2	1	36.4	14	3.575		3 575
October	68.0	25	27.2	17	2.816		2 816
November	66.0	3	14.5	29	.933	3.0	1.233
Year 1902	89.0	July 7	— 4.5	Jan. 29	28.121	34.75	31.596
" 1901	94.0	July 2	—14.0	Jan. 19	23.607	45.10	28.117
" 1900	96.0	Aug. 6	—14.0	Feb. 26	20.011	61.7	26.181

Number of Days Sleighing: December, 19; January, 31; February, 25; total, 75 days, compared with 67 days in 1901 and 70 days in 1900.

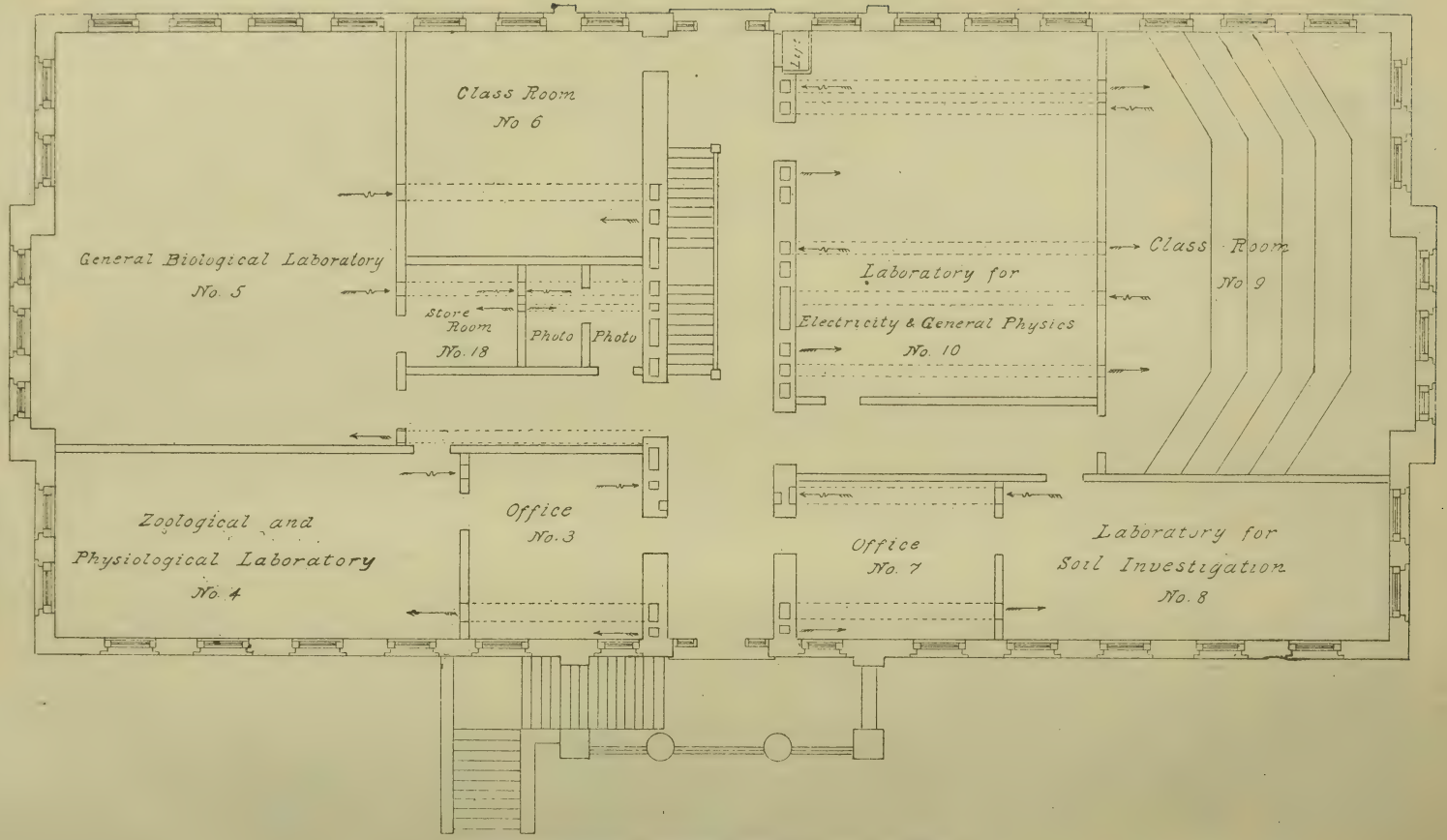
THE NEW PHYSICS LABORATORY.

We were enabled to occupy the new quarters for the college year 1902-1903. The various rooms allotted to this department are as follows: Two offices, one class-room, two laboratories on the first floor for third and fourth year work, and one large laboratory, 36 x 50, on the second floor for first and second year work. These rooms have been well supplied with furniture, such as tables, cupboards, chairs, and stools. The department is now enabled to provide instruction in all branches of Agricultural Physics. For laboratory work, we are as yet scantily supplied with apparatus, but hope that this deficiency will be shortly made up.

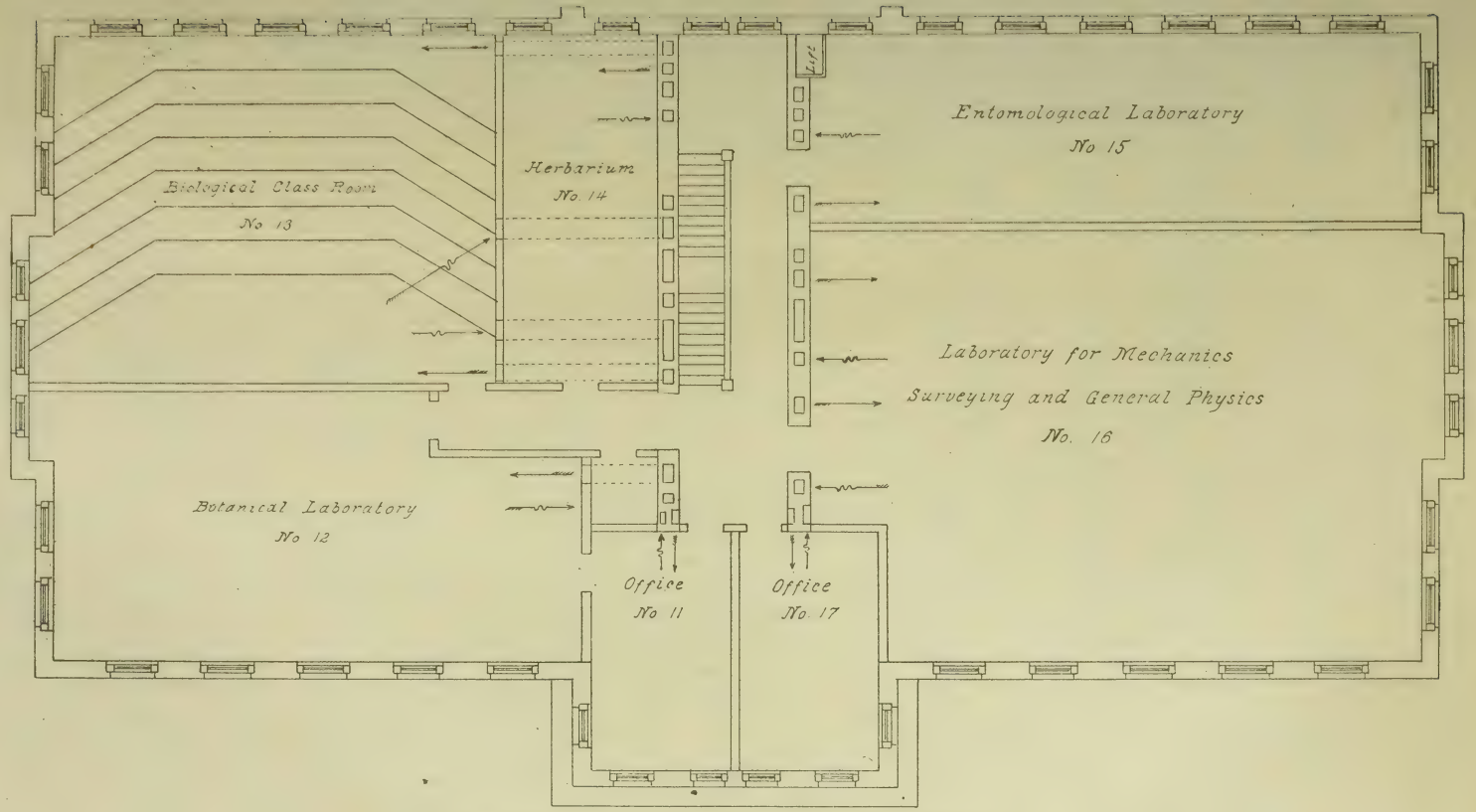
In conclusion, allow me to thank you for your continued sympathy and support. Through your liberal understanding of the needs of the work under my charge, I was this year provided with a Fellow in the department. While fully appreciating the value of this provision, as a beginning, I beg to remind you that the position of Fellow lacks the permanence in occupancy that is conducive to the best work, and request, therefore, that an Assistantship be granted to this department.

Respectfully submitted,

J. B. REYNOLDS.



Physical and Biological Laboratory, Ontario Agricultural College.
First Floor.



Physical and Biological Laboratory, Ontario Agricultural College.
Second Floor.

PART IV.

THE PROFESSOR OF BIOLOGY AND GEOLOGY.

To the President of the Ontario Agricultural College:

Sir,—I have the honor of presenting herewith my Fifth Annual Report on the work done by the officers of the Biological Department during the year 1902.

Allow me, at the outset, to thank you for the liberal appropriations for the maintenance and equipment of my Department during the past year. While it is true that the appropriations were larger than usual, it is also true that the many demands which were made upon this Department involved a greater expenditure than usual. Our work is very comprehensive in its scope. It comprises the vast and many-sided fields of Botany, Entomology, General Zoology, and Geology. Each of these requires its own peculiar treatment, and its own equipment for work when instruction is given mainly in the laboratory. In the third year, for example, there are twenty-six students, who must be handled at one time. We have only fifteen microscopes, and an equipment for about six students in Practical Plant Physiology. To do efficient work, we need twelve additional microscopes, and a much larger equipment for Plant Physiology.

In my last two reports, I emphasized the pressing need for an Insectary, in which the life-history of insects can be worked out by the students. I had hoped that this want would be supplied with the erection of the new building, but I was doomed to disappointment.

After a year's experience in conducting a large class in practical Plant Physiology, I feel the pressing need for a green-house, which will serve both as an insectary and a physiological laboratory.

I beg, therefore, to call your attention to the great need for:

1. A green-house, to serve as an insectary and a laboratory for Experiments in Plant Physiology.
2. Twelve new microscopes, for the use of the second and third year students.
3. Additional equipment for practical work in Plant Physiology.
4. More assistance to enable us to carry on investigations into the life-histories of injurious insects and fungi which destroy the farm and garden produce of the Province. With the introduction of the Nature Study Course in April, May and June, very little time will be left the present officers of this Department for conducting investigations along these lines.

Class-Room and Laboratory and Instruction in Biology.

The new building, which we were privileged to occupy in September, is well adapted for our work, and already there is abundant evidence that better work is being done than was ever possible in the past. It is now possible to give every student that individual attention which is so necessary for the doing of good work.

On the first floor are an office, a pathological and physiological laboratory for 25 students, a general biological laboratory for 50 students, a seminary-room, a store-room, and a photographic-room; on the second floor are an office, a histological laboratory for 35 students, a large lecture-room, a

herbarium, a store-room, and an entomological laboratory for 45 students. (See Plans).

In August, Prof. Doherty, who had not been well for some months, obtained leave of absence for a year, with the hope that a rest from his somewhat arduous teaching duties might restore him to his wonted health In September, Archibald Henderson, B.A., a graduate of Toronto University, and a specialist in Biology, was appointed assistant during Prof. Doherty's absence. He has done good work, and but few changes have been made in the arrangement of the Classes. T. D. Jarvis, B.S.A., Fellow, relieved Mr. Henderson of the field and laboratory work in Botany of the First Year, while I took over the Fourth Year Class in Grasses and Forage Crops.

In addition to the instruction given in the class-room and laboratories, to the regular students of the four years, considerable time and attention were given in January to the Short Course students, in the study of weeds, weed-seeds, and poultry parasites.

Following is a brief synopsis of the regular courses given in 1902 in Botany, Entomology, Zoology, and Geology.

Botany, First Year. (a) Field excursions, where the student familiarizes himself with the names of the common wild plants, learns their manner of growth, and the ways the fruit and seeds are produced and disseminated; (b) Laboratory studies of the entire plant, including root, stem, leaves and fruit; and (c) Lectures summarizing and illustrating the practical work,—by Messrs. Henderson and Jarvis.

Botany, Second Year. (a) Field excursions and laboratory studies in the morphology of plants, and their classification, a critical study of weed-seeds, and an elementary course in the study of grasses and fungi; (b) Lectures (two every week) on the morphology, classification, and physiology of plants,—by Mr. Lochhead, Mr. Doherty and Mr. Henderson.

Botany, Third Year. (a) Laboratory and lecture courses in systematic botany, including grasses, by Mr. Doherty; (b) Laboratory and lecture courses in fungi and plant pathology, by Mr. Lochhead; (c) Lecture and laboratory courses in plant physiology, by Mr. Lochhead and Mr. Jarvis.

Botany, Fourth Year. Specialists in Biology and Horticulture. (a) Laboratory and lecture course in plant histology by Mr. Henderson; (b) Laboratory course in fungi and plant pathology by Mr. Lochhead and Mr. Jarvis; (c) Seminary and practical course in plant physiology by Mr. Lochhead.

Botany, Fourth Year. Specialists in Agriculture and Biology. (a) Laboratory course in systematic botany, by Mr. Doherty; (b) Lecture and laboratory courses in grasses and forage crops, by Mr. Lochhead.

Botany, Fourth Year. Specialists in Horticulture. (a) A laboratory course in the study of cultivated plants, by Mr. Lochhead.

Entomolgy, Second Year. A course of thirty-five lectures, demonstrations and practical exercises. The chief insect pests of the farm, orchard and garden are discussed and studied, under Mr. Lochhead and Mr. Jarvis.

Entomology, Third and Fourth Years. This course, consisting of lectures and practicals, deals with both beneficial and injurious insects, and is a continuation of the second year course. Here, the students become acquainted with the literature of the subject, by Mr. Lochhead and Mr. Jarvis.

Zoology, First Year. This course, owing to lack of room last spring term, consisted of lectures and practicals, thirty in all. The chief animal types from the Amoeba to Mammals are discussed, by Mr. Doherty and Mr. Jarvis.

Zoology, Fourth Year. Specialists in Biology. A lecture and laboratory course, by Mr. Henderson.

Geology, First Year. A course of thirty lectures and demonstrations, dealing with the common minerals and rocks, the chief agencies operating in the formation of soils, and the geological history of the rock formations of Ontario,—by Mr. Lochhead and Mr. Jarvis.

Geology, Third Year. This course is a continuation of the first year course, but it is of a more practical nature, because the class is smaller. Considerable attention is given to the formation of soils through glacial action; and the geological history of North America is studied, with special emphasis on the Canadian region,—by Mr. Lochhead.

The work of instruction has been very exacting, both on account of the large number of classes which were placed in charge of the officers of this department, and the large amount of time required for procuring laboratory material, for collecting flowering plants, fungi and insects, and for mounting these as part of our permanent collections.

I would be doing an injustice to Mr. T. D. Jarvis, Fellow in this department, if I did not recognize the value of his services during the year. He has been a faithful collector, and an efficient helper in the laboratory.

Outside Work.

(1) Correspondence. About one thousand letters were written to correspondents, who made inquiries regarding weeds, weed-seeds, insects and fungous diseases. Frequently, such inquiries necessitated some investigation, especially in the case of injuries done by insects and fungi.

(2) The preparation of Special Articles for the Agricultural Press. This phase of outside work is becoming an important one, but one which is a great time-consumer. Some idea of the variety of topics discussed may be obtained from the following list:

(a) The Plum-Twig Gall-Mite, in Canadian Horticulturist, p. 150.

(b) Ammonia-Copper Carbonate, in Can. Hort., p. 304.

(c) Fruit-Growing on St. Joseph and Manitoulin Islands, in Can. Hort., p. 387.

(d) Hollyhock Rust, in Can. Hort., p. 294.

(e) Black Knot, Lecanium Scale, Millipedes, and Mustard Spraying, Can. Hort., pp. 388-9.

(f) The Hessian Fly, in Montreal Weekly Star.

(g) The Wire-Worm and How to Destroy It, Farming World.

(h) The Potato Blight, in Weekly Sun, Can. Hort., p. 410.

(j) Warning Against Tent-Caterpillars, Codling Moth, Plum Curculio,

(i) The Care of Our City Streets, in Guelph Herald and Mercury.

(i) Warning Against Tent-Caterpillars, Codling Moth, Plum Curculio, and Brown Rot, in Guelph Mercury, May 23rd.

(3) The Preparation of Bulletins and Reports. Three bulletins were prepared during the year: (1) A Spray Calendar—Treatment of Insect Pests and Fungous Diseases (Bull. 122); (2) The Story of the Cabbage Butterfly, as part of Nature Study Bulletin 124; and (3) Peas and the Pea-Weevil, in co-operation with Mr. Zavitz (not yet published).

In January last, I presented my Third Annual Report as Inspector of Fumigation, which was printed as part of the Report of the Minister of Agriculture for Ontario. With the permission of the Minister of Agriculture, I resigned the position of Inspector of Fumigation Appliances, which I had held for three years.

At the meeting of the Experimental Union in December, I presented a Report on Co-operative Experiments on the Treatment of Oats for the Prevention of Smut. Although the number of experimenters was not large, yet the results secured showed clearly that smut in oats can be entirely prevented by the use of formalin solution. This solution gave much better results than bluestone, and is to be recommended. (For full details of treatment, see Report of Experimental Union).

(4) Addresses at Farmers' Institutes and Fruit-Growers' Meetings. In June, I addressed Farmers' Institute meetings at Port Elgin, Owen Sound, Markdale, Shelburne, Beeton, and Duntroon; in August, at Sandfield, in the Manitoulins, and at the Sailors' Encampment on St. Joseph Island. In July, I addressed seven meetings of Fruit-Growers in Prince Edward Co. on matters pertaining to insects, fungous diseases, and spraying.

(5) Papers and Addresses for Annual Meetings. At the Annual Meeting of the Entomological Society of Ontario, held in London, Oct. 29th and 30th, I read the following papers, which will appear in the forthcoming Annual Report of the Society: (1) "The Injurious Insects of the Season of 1902;" (2) "A Key to the Insects of the Orchard;" (3) "How to Control the Pea-Weevil." On the evening of Oct. 29th, I delivered the annual illustrated popular lecture in the lecture-room of the Normal School. The subject was "Some Common Butterflies, and Some Noted Butterfly-Hunters." I had also the honor of being elected President of this Society for the coming year.

During the last week of June, I attended the meetings of the Association of Economic Entomologists of America, and those of the American Association for the Advancement of Science, held in the Carnegie Institute, Pittsburg.

At the Annual Meeting of the Fruit-Growers' Association, held in Walkerton Dec. 1st, 2nd and 3rd, I delivered an address on the "Injurious Insects and Fungi of 1902."

The Museum.

In the new Biology-Physics Building, ample accommodation has been provided for a College Museum on the ground floor. Cabinets and shelving are needed, however, to display the collections, and these we hope to procure by an appropriation from the Legislature at the coming session. A well-appointed agricultural museum is a necessary part of the equipment of a college such as ours, where so much of the instruction is given on the Nature Study plan, and which is visited by more than 35,000 persons every year. The heads of the Departments of the College are willing to co-operate in making the display an educational one. The various collections will be grouped into sections and thoroughly labelled, so that it will be an easy matter for a visitor to get much valuable information regarding the insects, plants, fungous diseases, relics, soils, rocks, minerals, woods, animals, bacteria, fruits, and seeds, in which he may be interested. It will be necessary, however, to procure as soon as possible many additions to our present meagre collections, if the educational feature is to be made prominent. I would, therefore, respectfully urge that an annual appropriation be made for the purchase of desirable exhibits for our Museum, and also that certain valuable local collections of insects, birds, and other animals, be purchased at once, before they are taken to the museums of the United States.

Some Injurious Insects and Fungous Diseases of the Year 1902.

1. A Saw-Fly Larva, Which Injures Apples. Many apple-growers report that considerable damage was done to ripe apples at apple-picking time by the larva of a saw-fly, which burrowed into the fruit to a depth of half an inch or more. The larva is about one-third of an inch in length,

bluish-green on the upper surface, and light green beneath. I was unable to work out the life-history of this saw-fly, but Dr. Fletcher informs me that it is probably *Taxonus nigrosoma*, a form not very often reported, and hitherto not suspected of damaging fruit.

In most of the damaged apples there were many burrows,—in one I counted eleven, and every burrow contained a larva. The burrow is slightly larger than the larva, and is closed externally by a film of the tissue of the apple, put in place by the larva. The appearance of the burrow suggests that it is a place of hibernation, and it would appear as if the insect passed the winter in the larval condition. This condition, however, is not the usual one for saw-flies, and it may be that these particular larvae are belated forms, which did not reach maturity before the cold weather set in.

Regarding the habits of the larvae of this saw-fly, Mr. J. G. Jack (Can. Ent. XXV., p. 183) says:

"When they ceased feeding at full growth, the larvae abandoned the leaves of their food plant, which was *Polygonum Muhlenbergii* and prepared for pupating by boring into the green stems of the food-plant, or sometimes into some such substance as partially decayed wood, if it happened to be in the vicinity. In these burrows, pupation takes place without the formation of any cocoon. Within a week or two after entering their burrows, the insects emerge as saw-flies."

2. The Woolly Aphis of the Apple and Other Trees. For many reasons, we believe that the woolly aphis is increasing rapidly in the orchards of the Province, and is doing much serious injury. More reports than usual have reached us this year regarding the attacks of this pest; and, as its life history and habits are not generally known, a short account at this time and in this report may be acceptable.

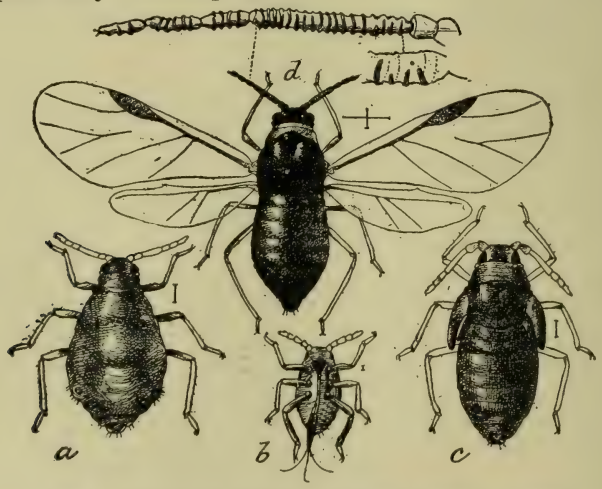


Fig. 1.—Woolly aphis (*Schizoneura lanigera* Hausm.)—*a*, agamic female; *b*, larval louse; *c*, pupa; *d*, winged female with antenna enlarged above; all greatly enlarged and with waxy excretion removed. After Marlatt, Division of Entomology, Department of Agriculture, U.S.

The Woolly Aphis (*Schizoneura lanigera*) usually exists in two distinct forms, one inhabiting the roots, and the other the stems. The root-inhabiting form is by far the more injurious, but is the less conspicuous. This insect may winter over in three ways: (1) as an egg in the crevice of the bark, deposited by a wingless female, after fertilization by a wingless mate at the close of the season; (2) some of the members of the stem colonies may possibly survive our winter, but it is very probable that most of the

colonies perish; and (3) as an immature larva in the case of the root-inhabiting form. It is probable, also, that in early summer, the root-forms ascend to the stem and start stem-colonies, while in late summer the stem forms descend to the roots and become root-inhabiting forms.

In the spring, wingless females hatch from the eggs which have wintered in the crevices of the bark, and these reproduce themselves for several generations by giving birth to living young. Late in the season, winged females appear, which give birth to true-sexed, but wingless males and females. After mating, each of the females lays a single winter egg (Fig. 1). Throughout the summer, the infested branches are very noticeable. (Fig. 2.) The aphids occur in colonies or patches, and are covered with their

Fig. 2.—Woolly aphids on a stem.

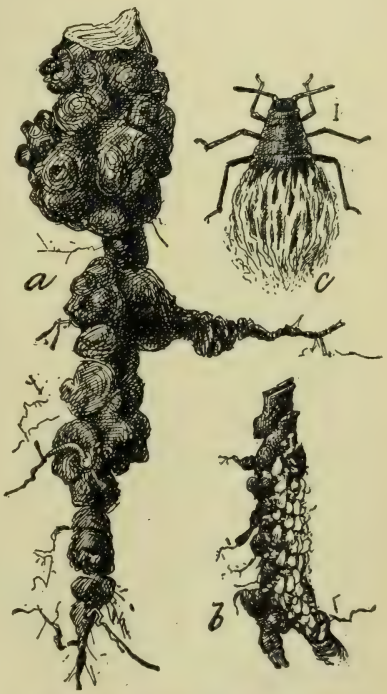


Fig. 3.—Woolly aphis—*a*, root of young tree illustrating deformation; *b*, section of root with aphides clustered over it; *c*, root louse, female; *a*, and *b*, natural size; *c*, much enlarged. After Marlatt, Division of Entomology, Dept. of Agriculture.

flocculent cottony excretions. When the larvae are all young, little or none of the white substance is excreted. As soon, however, as they begin to absorb much liquid food, which the aphids are able to do by means of their long sucking beaks thrust into the tender tissues of the stems, they begin to execrete the flocculent covering.

The injury done by the woolly aphis on the roots is very characteristic. Galls and other enlargements arise, which result, sooner or later, in the death of the organs affected (Fig. 3). In the cracks which open up in the galls, the aphids live in clusters, and in a short time the vitality of the tree is reduced to such an extent that it is no longer profitable. Like many other sucking insects, woolly aphids injure their hosts in two ways: (1) by

appropriating the juices which should go to the nourishment of the tree, and (2) by poisoning the tissues so that gall-like abnormal enlargements occur at the points of attack. In most cases of infested young trees, it will pay better to cut them down and burn them at once, than to try to combat the aphids.

When the stems are clustered with woolly aphids the bark becomes deeply pitted, due to the fact that the growth of the cells at the point of attack is stopped.

Several methods are recommended for the destruction of the root-inhabiting forms. (1) Hot water, but little below the boiling point, when applied about the base of young trees in sufficient quantity to wet the soil to a depth of several inches, has been found to be effective and practicable. (2) Tobacco stems, when broken up finely and distributed about the base of the infested trees, are also very effective. The surface soil should be first removed, the tobacco applied, and the soil replaced. The rains will carry the tobacco solution down among the roots, and destroy the aphids. (3) Carbon bisulphide, when poured into two or three holes about the tree, but not closer than two feet from the stem, is also effective. Into each hole, eight or nine inches deep, an ounce of the liquid should be poured, and the opening immediately closed. The liquid evaporates quickly, and the heavy fumes penetrate the soil about the roots, killing the aphids. The roots of nursery stock suspected of bearing aphids should be dipped in a strong solution of tobacco stems, or in hot water (temp. 150 degrees F.) for a few seconds, or in a hot soap solution, before the trees are planted.

The stem-inhabiting forms can be readily destroyed by applications of Kerosene Emulsion diluted with ten parts of water, or with soap wash.

3. A Bronze Beetle, Which Kills Birch Shade Trees. In several cities of Ontario, notably Guelph, London and Hamilton, the white birches are suffering from the attacks of the Bronze Birch-Borer (*Agrilus anxius*). This insect has not before this season been reported from Ontario, although it has been inflicting serious injuries on the birch shade trees of Buffalo, Detroit, Ann Arbor and Chicago. For the past two years, however, many birches of Guelph showed evident symptoms of disease, but it was thought that the causes were lack of water and food. A study of some of the badly-injured trees at Guelph and Hamilton revealed the true cause of the trouble. The bark of many of the limbs was riddled with holes, and within the wood there was a labyrinth of burrows, made by beetle-borers. The borers begin burrowing at the top of the tree, and gradually work downwards. For this reason, the tree begins to die first at the top, and careful examination is sometimes necessary to distinguish this condition from "Stag Head," produced by a lack of moisture and food materials.

The courses of the burrows made by the grubs are very irregular. Sometimes their labyrinthine courses can be traced for a considerable distance in the cortex and young wood, but frequently they run directly into the wood, and emerge again at the surface. A stem infested with borers can usually be told by the large number of ridges on the bark. In every case examined, a burrow ran beneath the ridge.

The effect of all this burrowing is to weaken the branches, and to interrupt the supply of food and food materials to the parts above. Death of the affected parts soon follows. In two or three seasons, the whole tree becomes riddled with holes and honey-combed with burrows, and death follows as a natural consequence.

The larva is of a creamy-white color, and 2-3 inch in length when full grown; the mouth-parts are nearly black; and the first thoracic segment (just behind the head) is much wider than the other segments.

The beetle is between one-third and one-half inch in length, and is an olive-bronze in color (Fig. 4).

The life-history of the Bronze Birch-Borer is about as follows: The adult female beetle emerges from their burrow late in May, and straightway begins laying her eggs in crevices on the bark. The larvae hatch in June, and are not full grown when winter sets in. They remain torpid during the winter, and become full grown in April or early May.

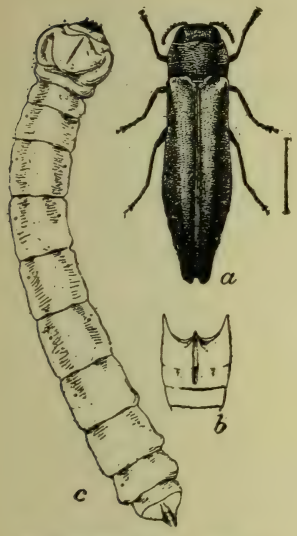


Fig. 4.—Bronze Birch Borer; *a.* female beetle; *b.* first abdominal segments of male from below; *c.* larva from above—all enlarged about 3½ times. After Chittenden, U.S., Dept. Agr., Div. Ent., Bull, 18, n. s.

Fig. 6.—Leaf spot of the sugar-beet; *a.* the characteristic spores of the fungus causing the disease; *b.* the spore-thread bearing the spores (highly magnified).

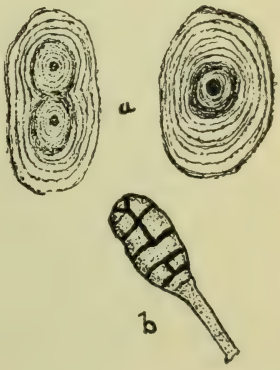


Fig. 5.—Brown Spot of tobacco. *a.* two spots, showing the concentrically zonal structure; *b.* a spore of *Macrosporium longipes*, the cause of the Brown Spot. (Original.)

Regarding the mode of escape of the beetles from the burrows, Mr. John Larsen (Mich. Acad. Sc., 3rd Report, p. 47), who made a special study of this insect, says: "The larva burrows out near the bark, then turning into the wood at a slight angle, an enlarged oblong chamber is formed in which the larva rests and undergoes further development in the spring. The burrow has been carried outward in rather a sharp curve, which brings its end to just beneath the bark beyond the chamber. When the beetle is ready to escape, it makes its way to this; and, eating through the bark, escapes. The larva is often found doubled up in the chamber. Normally, it lies with its ventral side turned outward, and the beetles are found in this position. Some were found reversed, and could not escape. The escape is rather laborious, as the insect must squeeze its way to the bark, and then, eating a small hole again, squeeze its way through. Beetles are found with the forward parts of their bodies protruding for hours, making long rests between efforts to free themselves. When the beetles leave the trees they leave a hole, which in outline has one straight side and one curved."

It is impossible at this stage in the study of the insect to indicate a definite line of remedial treatment. As the beetles are capable of flight, it is very necessary that dying and dead trees should be cut down and burned before the escape of the beetles in May.

We must, in addition to the foregoing measures, rely largely on the woodpecker to control the pest.

4. A New Disease of Tobacco. Early in September, the lower leaves of the tobacco plants in the College garden began to show symptoms of disease. Brown spots appeared on both surfaces of the leaves, which rapidly enlarged, so that within a week, the leaves were literally covered with large, round, brown, dead patches. (Fig. 5a.) From the lower leaves, the diesase spread to the upper ones; and when the crop was harvested, there was scarcely a leaf which was free from the Brown Spot. At first, no spores could be found, and the name of the fungus was in doubt. Finally, however, about two months after the plants were cut, spores were discovered, and identified as belonging to the fungus called *Macrosporium longipes* (E. & E.), a close relative of the tomato rot and the early potato-blight fungi.

The characters of this fungus are: (1) The concentrically zoned spots; (2) the club-shaped and three to seven celled spores; and (3) the long stems of the spores (Figs. 5, 6).

This fungus was first described by Ellis & Everhart, in 1892, in the Journal of Mycology, Vol. VII., p. 134, from specimens of diseased tobacco leaves found in North Carolina; but not much notice has been taken of it since. It is very probable that one or two applications of the Bordeaux Mixture during August will keep this fungus in check.

5. A Leaf Spot of the Sugar Beet. Already growers of sugar-beets are making inquiries about a disease which produces a spotting of the leaves. The cause of the disease is a fungus called *Cercospora beticola*. It is by no means a new disease with us, for it may be found in almost every plot of mangels and beets grown under ordinary conditions. But, with the gradual development of the sugar-beet industry, and the cultivation of larger areas of the sugar-beet, we may expect to hear much about this disease.

The leaf-spot fungus first appears as small brown spots, with a purplish border, which are scattered irregularly over the leaf. The spots gradually become so numerous that the leaf is completely discolored and parched. Finally it blackens, dies, and drops off. If a little of the material of the dry spot be scraped off with a knife and examined in a drop of water, on a glass slide under a microscope, spores shaped like those in Fig. 6 may be seen. They are borne at the ends of short stalks, but are easily dislodged by the wind. They are readily carried to healthy leaves, where they may germinate and enter the tissues and reproduce the disease.

Sorauer, a great German authority, is of the opinion that this fungus may also be found on the peduncles and bracts of the flower, and even upon the seed-pods. He thinks that the seed may be the means of transmitting the disease.

The best methods of controlling this pest are: (1) To spray the crop with Bordeaux Mixture at intervals of three weeks, commencing when the plants are five to six inches high; (2) to adopt a rotation, and never to grow the sugar-beets on the same field two years in succession; and (3), to destroy all of the leaves. If the "tops" are fed to cattle, the manure should not be spread on land intended for sugar-beets.

6. A Leaf-Spot of the Horse-Chestnut. In many parts of the Province the horse-chestnut shade trees were attacked by a fungus, which caused a spotting and a dying of the leaves; and, in many cases, when seriously attacked, the leaves fell from the trees. This fungus is known as *Phyllosticta sphaeropsoidea*.

On account of the absence of any system of spraying in our towns and cities for the control of fungous diseases and injurious insects, there is a danger that this disease may cause serious loss in a few years by the death

of these valuable shade-trees. Experiments have shown that the disease can be controlled by applications of Bordeaux Mixture, and, to some extent, by the burning of the fallen leaves.

7. The Shot Hole Disease of the Plum and Cherry. This disease was very prevalent and destructive during the past season. The fungus (*Cylindrosporium padi*) forms numerous, small purplish spots on the leaves. These become brown, and finally fall out, giving the characteristic appearance as if riddled with shot (Fig. 7). The injured leaves usually fall from the

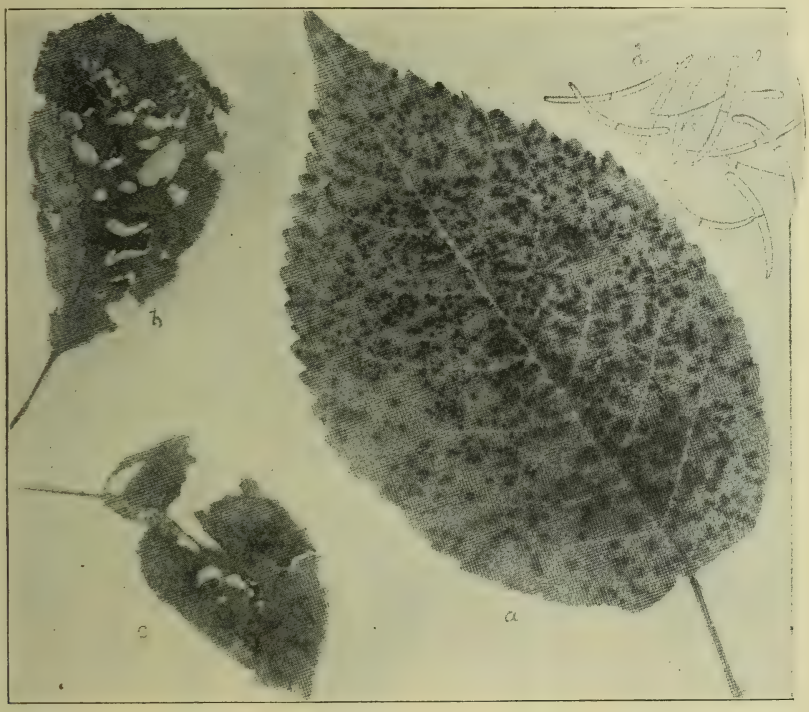


Fig. 7.—Shothole Fungus of plum and cherry (*Cylindrosporium padi*); *a.*, *b.*, *c.* leaves in various stages of attack; *d.* the spores of the fungus (much magnified).

tree, the growth is stopped, and fruit is seriously injured. Often a new crop of leaves is put forth, but this is followed by an immaturity of the wood, and the tree is very liable to suffer during the winter. As a matter of fact, this fungus is the primary cause of the winter-killing which is so common in some of our plum and cherry orchards. This disease may be prevented by spraying with Bordeaux Mixture. The first application should be made when the leaves are but half grown; the second and third applications at intervals of three weeks.

8. A Rot on Bean Pods Affected with Anthracnose. In November many of the bean pods which were affected with Anthracnose (Colletotrichum lindemuthianum), were observed to be rotting to a slight extent. The rotting areas were the Anthracnose areas, which in normal seasons do not soften. Moreover, a pink, thread-like growth, resembling a mould, covered the decaying spots. On examination, it was found that the fungus growth was that of *Cephalothecium roseum*, a supposedly saphophytic fungus. The spores and spore-bearing stalks were abundant, and could not be mistaken. The spore is oblong in shape, and slightly constructed at the middle by a partition, which divides it into two cells. (Fig. 8.)

That this fungus is the cause of the rotting, there can be little doubt, and the question naturally arises, May this fungus sometimes act as a parasites on living tissues? It is very probable that it is, at least, a wound-para-

Fig. 8.—Pink Rot on bean anthracnose. *a*. spores and spore-threads of the Pink Rot, showing the shape, and arrangement of the spores. (After Cornell Bull. 207); *b*. bean pods attacked by anthracnose.

site, for the same fungus has been observed on the scab spots of apples this year (See Bull. 207, Cornell Univ.).

9. Other Injurious Fungi of 1902. The season of 1902 was abnormally moist, and was very favorable to the development of most of the injurious fungi of the orchard and garden.

The Apple Scab was very prevalent in all orchards, except those that were thoroughly sprayed with Bordeaux Mixture. The first spraying should be done when the buds are swelling, the second just before the blossoms open, the third when the leaves have fallen, and a fourth three or four weeks later.

The Pear Scab was also very abundant, and there was much cracking of the fruit. Bordeaux Mixture will prevent the development of this fungus also.

The Sooty Fungus of apple (*Leptothyrium pomi*) was more common than usual, on account of the excessive moisture in most orchards.

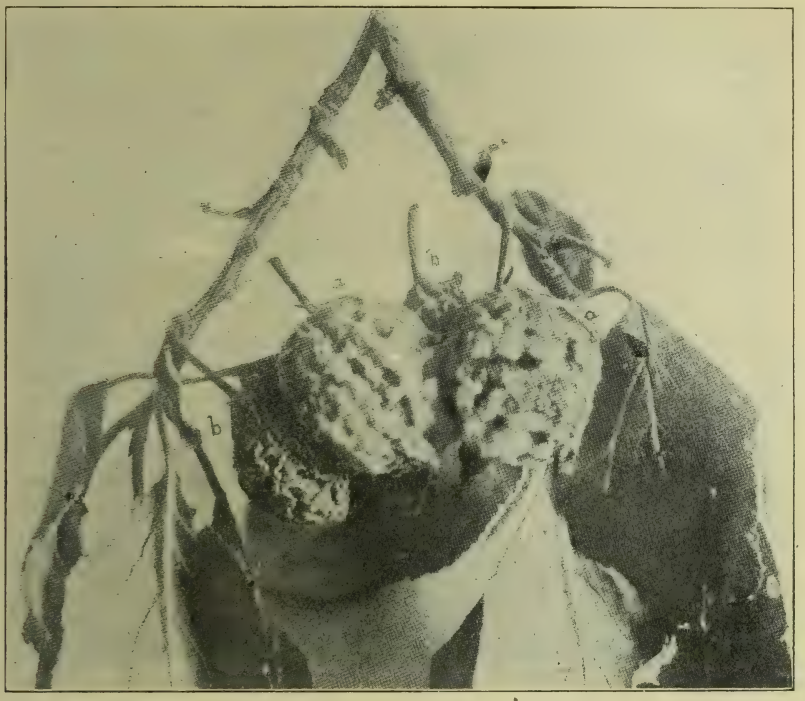


Fig. 9.—Brown Rot of Plum (*Monilia fructigena*); *a*. Plum in the soft stage with abundant production of spores; *b*. Plums in the dry, "mummy" stage. After N.Y. Ag. Exp. St. Bulletin.

The Brown Rot was very destructive in 1902 in many plum orchards, and is, perhaps, the most serious of all the diseases affecting the stone fruits (Figs. 9 and 10). To combat this fungus, not only is thorough spraying with Bordeaux necessary, but also the burning of all the dry,

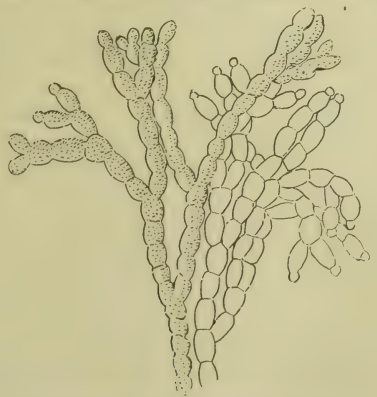


Fig. 10.—Spores of Brown Rot of Plum. (*Monilia fructigena*).

rotted plums of the previous year. The first spraying should be done before the buds open, and subsequent applications should be made every three weeks, until the plums are nearly full grown.

The Late Blight of Potatoes, or Potato Rot, was very destructive over the whole Province. The potato-grower has been in the habit of treating only for the potato beetle, but the experience of the past year should convince him that there is another enemy which may sometimes do more injury than the beetle.

As a combination mixture of Paris Green and Bordeaux will control both the beetle and the rot fungus, it should be applied every year to these crops. It is not difficult to prepare, and is as easily applied as is the Paris green alone.

Respectfully submitted,

W. LOCHHEAD.

THREE DANGEROUS TREES IN FRUIT DISTRICTS.

By T. D. Jarvis, B.S.A.

The Mountain Ash, Wild Plum, and Chokecherry are three common trees in the fruit districts of Ontario.

Botanically, the Mountain Ash is closely related to the apple and pear, and observation shows that the same insects are to be found on all three. Among these are the bud-moth, cigar case-bearer, tent-caterpillar, canker-worm, oyster shell bark-louse, scurfy bark-louse, apple plant-louse, and San Jose scale.

The Wild Plum has the same insect and fungous enemies as the cultivated plum, which is closely related to it. On these can be found the plum curculio, brown rot, and the shot-hole disease.

The Chokecherry and the cultivated cherry, which are also close relatives, have the same destructive enemies, viz., the tent-caterpillar, shot-hole disease, and the brown rot.

An extensive fruit-grower near Hespeler has an orchard (plum), surrounded by a double hedge-row of wild plum trees. Towards the end of June of the past season, I inspected his orchard, and found that the plums were badly damaged by Brown Rot. On inquiry, I found that this farmer had sprayed his plum trees, but had neglected to spray his wild plum hedge. He was surprised that the spraying had done very little good; but when I pointed out the Brown Rot in abundance on the wild plums, he ceased to wonder that his spraying had so little effect.

In the suburbs of London, Ont., I found an apple orchard, surrounded by a row of Mountain Ash trees. This was about the middle of May, when the bud-moth is in the most destructive stage. Nearly all the buds examined on the Mountain Ash trees contained a grub, which was the larva of the bud-moth. The apple trees were in a similar condition, in spite of continued sprayings. The explanation of the apparent ineffectiveness of the spraying in this case was the fact that the Mountain Ash trees harbored successive generations of Bud-Moths, that migrated yearly to the apple trees.

Complete, thorough, and timely spraying would be a satisfactory safeguard, notwithstanding the presence of insects and fungous diseases on neighboring trees; but no spraying is complete, and it is, at the best, running a foolish risk, to keep one's orchard surrounded by a congenial habitation for insect and fungous pests.

As for remedial measures, I would suggest the following: If the wild trees are few in number, they should be sprayed. On the other hand, if their preservation is not important, they should be cut down.

PART V.

THE ASSOCIATE PROFESSOR OF BIOLOGY.

To the President of the Agricultural College:

Sir,—I beg to submit herewith my Second Annual Report as Associate Professor of Biology.

In making this report, I do so under regrettable circumstances. For some time my health was in a precarious condition, and, on medical recommendation, I was persuaded to apply in September for leave of absence, which you very kindly granted to me. Though not yet entirely recovered, I hope soon to be able to resume my duties.

Much of my time was occupied by lecture and laboratory work during the College session. Unfortunately, the conditions present in the old Biological Building were such as to make it impossible to obtain from laboratory work the best possible results. However, the new Biological Building furnishes much improved facilities, and it may be fairly expected that the students will acquire, as a result of the increased practical work, a much more thorough and lasting knowledge of natural science. Weed-Seed Identification and Systematic Botany received more attention than in previous years. Laboratory work was introduced in Zoology, and the results from the increased practical nature of the studies, were in every way gratifying.

Mustard Spraying.

Acting under instructions, I undertook demonstrations in mustard spraying during the month of June. I proceeded to Beachville, Nilestown, Parkhill, Stratford, Scarboro' Junction and Shelburne, making arrangements for carrying out practical demonstrations. Later, I visited these places in the order named, spraying in each case from two to ten acres. These demonstrations were in many cases largely attended by interested farmers, who, had they not seen the demonstrations performed, and the results which followed, could never have been otherwise convinced of the practibility of this method for destroying mustard.

From reports which have been received, it appears to be more certain than ever that this method is of the greatest value to farmers whose fields are invested with this weed pest. In every case where the spraying was not interfered with by rain, the results were highly satisfactory.

I would advise that in future years a far greater number of demonstrations be given during the month of June. As the period during which these operations can be carried on lasts only two weeks, it becomes necessary that to cover anything but a very restricted area, a number of spraying parties be organized, each being given certain counties. The importance of the work will justify increased attention and expense along this line.

Herbarium Work.

Owing to the fact that a large number of our common plants are missing from our Herbarium, it was deemed advisable to undertake the bringing together of a fairly complete and representative collection of the plants of

this district. Several hundred plants were added during the past year, and it is hoped that shortly the flora of this district will be completely represented in our Herbarium. It is very desirable that increased attention be paid to the herbarium work of this Institution. Not only should the flora of the more settled districts be well represented, but collections should be made in the new regious, which are likely to undergo a complete transformation during the coming years.

Ornithology.

Increased attention has been paid during the past year to the study of the habits of our various species of birds, and, by your kind permission, we were enabled to have two lectures given to the students by Mr. C. W. Nash.

Much time was given during the spring and summer months to the observation and study of the injurious and beneficial habits of our native birds. The notes collected will form the subject of a later report.

Below is given "Bird Migration Notes" for 1902. In the collection of these notes, I desire to express by thanks for the valuable services rendered by Messrs. Kels, Klug and Beattie.

Bird Migration Notes.

The following table gives information regarding birds, observed by members of the Wellington Field Naturalists' Club, 1902:

Name of Bird.	First seen.	About how many were seen.	Next seen.	Became common	Last seen.	Common or Rare.	Does it breed near your Station.	Remarks.
Pine Grosbeak	Jan. 1	15	Jan. 2	.....	Ap'l 13	Not C..	No.	Winter visitor.
Evening Grosbeak	Feb. 6	75	Mar 24	.....	Mar 24	Rare ...	no..	"
Slate Colored Junco	" 8	6	Feb. 11	Mar. 23	Nov 8	C	yes.	
American Merganser	" 9	7	" 11	.....	Feb 15	Rare ...	no..	
Blue Jay	.....	....	.....	Res'dt.	.....	C	yes.	
Prarie Horned Lark	Feb. 15	2	Feb. 23	Mar. 10	.....	.....	....	
American Crow	" 15	8	" 22	" 7	.....	C	yes.	A few remain through the winter.
American Robin	" 15	1	Mar. 2	" 3	Nov 13	C	"	
Purple Finch	" 19	6	Feb. 22	Ap'l. 29	.....	.....	...	
American Goldfinch	" 19	20	" 28	May 1	Nov. 30	C	yes.	A few remain through the winter.
Song Sparrow	Mar. 8	3	Mar. 9	Mar. 9	Nov. 13	C	"	
Chickadee	.....	...	.....	Res'dt.	...	C	"	
Bluebird	Mar. 10	1	Mar. 11	Mar. 12	Oct. 11	C	"	
Bronzed Grackle	" 11	2	" 14	" 21	" 6	C	"	
Killdeer Plover	" 12	1	" 15	" 27	" 10	C	"	
Red-winged Blackbird	" 12	2	" 22	" 27	Aug. 29	C	"	
Meadow Lark	" 15	10	" 16	" 22	Oct. 10	C	"	
Red-tailed Hawk	" 15	1	Ap'l. 12	....	....	Rare ...	...	
Red-shouldered Hawk	" 15	3	Mar. 16	Mar. 23	Oct. 10	Fairly C	yes.	
Mallard	" 15	2	Ap'l. 20	.....	May 28	Not C..	"	A few prs. breed.
Rough-legged Hawk	" 16	1	" 12	.....	.....	Rare ..	...	
American Herring Gull	" 23	50	May 2	....	May 10	Not C..	no..	
Tree Sparrow	" 23	F	Mar. 25	.....	Mar. 25	Not C..	no..	
Yellow-billed Sapsucker	" 23	1	Ap'l. 10	Ap'l 12	July 4	Fairly C	yes.	
Pine Siskin	" 23	F	" 6	.....	Ap'l. 14	C	"	
Savanna Swamp Sparrow	" 23	S	" 16	.....	.....	Not C..	"	
Ruffed Grouse	.....	....	.....	Res'dt.	.....	C	"	
Flicker	Mar. 24	1	Ap'l. 5	Ap'l. 15	.....	.....	....	

BIRDS OBSERVED BY WELLINGTON FIELD NATURALISTS' CLUB, 1902.—*Continued.*

Name of Bird.	First seen.	About how many were seen.	Next seen.	Became common.	Last seen.	Common or Rare.	Does it breed near your Station.	Remarks.
Vesper Sparrow	Mar. 24	S	Mar. 25	Ap'l. 12	Oct. 10	C	yes.	
Sparrow Hawk	" 25	2	" 28	.....	Aug. 19	Not C.	"	
Great Blue Heron	" 26	3	" 28	.....	Nov. 8	C	"	
Cowbird	" 26	1	Ap'l. 4	Ap'l. 5	July 4	C	"	
Downy Woodpecker	.....	...	.....	Res'dt.	.....	C	"	
Hairy Woodpecker	.....	..	.....	"	.....	Fairly C	"	
White Breasted Nuthatch	.....	...	.....	"	.....	C	"	
Phoebe	Mar. 27	1	Mar. 28	Ap'l. 5	Sep. 20	C	"	
White-rumped Shrike	" 28	1	Ap'l. 10	Ap'l. 15	July 25	C	"	Noticably scarcer this yr.
Golden-crowned Kinglet	.....	...	.....	Win'r r	.....	.....	....	
Kingfisher	April 6	1	Ap'l. 17	Ap'l. 25	Oct. 10	C	yes.	
Winter Wren	" 6	1	" 12	.....	.....	.....	"	
Canada Goose	" 7	F	" 16	.....	Ap'l. 20	.....	"	Passing migrants.
Towhee	" 10	1	" 11	Ap'l. 12	.....	Fairly C	"	
Cooper's Hawk	" 11	1	May 1	.....	.....	Not C.	"	
Swamp Sparrow	" 12	1	Ap'l 13	.....	.....	Not C.	"	
Chipping Sparrow	" 12	10	" 21	Ap'l. 23	Oct. 4	C	"	
Marsh Hawk	" 12	1	" 20	" 20	.. ..	Fairly C	"	
Tree Swallow	" 15	S	" 18	" 20	Aug. 17	C	"	
Wilson's Snipe	" 19	6	" 20	.....	.....	Not C.	....	
Barn Swallow	" 19	4	" 20	Ap'l. 21	Aug. 30	C	yes.	
American Goldeneye	" 20	30	.....	.....	.....	Rare	no.	
Woodcock	" 20	5	Ap'l 27	.....	.....	Fairly C	yes.	
American Bittern	" 22	1	" 29	Ap'l. 30	.....	C	"	
Ruby-crowned Kinglet	" 22	6	" 23	.....	May 6	Not C.	no.	Passing migrant.
Goshawk	" 22	2	" 28	.....	" 1	Rare	no.	
White-throated Sparrow	" 23	2	" 24	Ap'l. 24	Oct. 8	C	yes.	
Field Sparrow	" 23	1	Oct. 7	.....	" 7	Not C.	....	
Loon	" 24	2	May 3	.....	.....	Rare	no.	" "
Broad-winged Hawk	" 24	1	.....	.....	.....	Rare	...	
Spotted Sandpiper	" 25	2	Ap'l 27	May 1	Sep. 30	C	yes.	
Hermit Thrush	" 27	1	May 1	.....	May 3	Rare	no.	
Red Headed Woodpecker	" 28	1	" 11	May 11	Sep. 22	C	yes.	
Black and White Warbler	" 28	1	" 1	" 2	" 1	C	yes.	
Rusty Grackle	" 28	1	.....	.....	.....	Rare	....	A pair noted breeding.
Water Thrush	" 28	1	Ap'l 29	May 1	July 4	Fairly C	yes.	
Myrtle Warbler	" 28	1	May 2	.....	.....	.....	no.	Common during migrations.
Brown Thrasher	" 28	1	Ap'l 29	May 11	.....	Not C.	yes.	
Chimney Swift	Ap'l. 30	12	May 2	May 3	Aug. 26	C	yes.	
House Wren	" 30	1	" 9	" 13	Nov. 8	C	"	
Bank Swallow	" 30	4	" 1	" 16	.....	C	"	
Pintail Duck	May 1	S	" 2	.....	.....	Rare	no.	Spring and Fall visitor.
Bufflehead Duck	" 1	S	" 2	.....	.....	Rare	no.	" " "
Green-winged Teal	" 1	S	" 2	.....	.....	Rare	....	A few pairs breed.
American Scaup Duck	" 1	F	" 2	May 1	June 4	.....	yes.	
Short-eared Owl	" 1	1	.....	.....	.....	Rare	....	
Pigeon Hawk	" 1	1	.....	.....	.....	Rare	..	
Black-throated Green Warbl'r	" 1	S	May 2	May 2	July 31	C	yes.	A few breeds, mostly a passing migrant.
Bobolink	" 2	1	" 3	" 5	" 25	C	"	
Least Sandpiper	May 2	1	May 3	.....	.....	.....	no.	Passing migrant.
Bonaparte's Gull	" 3	4	.....	.....	.....	Rare	no.	
American Osprey	" 3	1	" 9	.....	.....	Rare	....	
Sharp-shinned hawk	" 3	1	" 5	.....	.....	Not C.	yes.	
American Eared Grebe	" 3	1	.....	.....	.....	Rare	no.	
Wood Thrush	" 3	1	" 13	May 16	.....	C	yes.	
Baltimore Oriole	" 4	1	" 8	" 16	July 25	C	"	
Yellow Warbler	" 4	1	" 8	" 5	Aug 11	C	"	
Blackburnian Warbler	" 4	1	" 7	.....	May 17	Not C.	no.	Spring migrant; few noted this year.
Kirtlands' Warbler	" 4	S	" 17	.....	.....	Rare	no.	Spring migrant.
Kingbird	" 4	3	" 5	" 6	Aug 29	C	yes.	
Whip-poor-will	" 4	1	" 11	" 16	.....	C	"	
Wilson's Thrush	" 4	3	" 13	" 15	.....	C	"	
Red-eyed Virco	" 4	1	" 5	" 8	Sep. 16	C	"	
Olive-sided Flycatcher	" 4	2	" 5	.....	.....	Rare	...	
Great-creasted Flycatcher	" 4	1	" 10	" 15	Aug 11	C	yes.	

BIRDS OBSERVED BY WELLINGTON FIELD NATURALISTS' CLUB, 1902.—*Concluded.*

Name of Bird.	First seen.	About how many were seen.	Next seen.	Became common.	Last seen.	Common or Rare.	Does it breed near your Station.	Remarks.
Magnolia Warbler	May 4	1	May 15		June 5	Not C.	?	Mostly a passing migrant.
Least Flycatcher	" 4	2	" 5	May 5		Fairly C	yes.	
Catbird	" 6	1	" 11	" 16	Sep. 20	C	"	
Solitary Sandpiper	" 6	1				Rare	no.	Passing migrant.
Ruby-throated humming bird	" 8	1	" 12	" 12	Sep. 15	Fairly C	yes.	
Yellow-throated Virco	" 8	1	" 9	" 15		C	"	
Yellow Legs	" 9	2						Passing migrant.
Purple Martin	" 10	2	" 17				"	
Maryland Yellowthroat	" 11	2	" 30			Fairly C	"	
Palm Warbler	" 11	4	" 17			Not C.	no.	Passing migrant.
White-Crowned Sparrow	" 11	1	" 13		Oct. 6	Not C.		
Mourning Dove	" 11	1	June 28		Aug 6	Not C.	yes.	
Rose-breasted Grosbeak	" 11	3	May 12			Not C.	"	Very scarce this year.
Oven-bird	" 11	3	" 14	May 17		C	"	
Black-throated Blue Warbler	" 11	1	" 15		May 20	Fairly C	no.	Passing migrant.
Redstart	" 11	2	" 15	" 20		C	yes.	
Canadian Warbler	" 11	2	" 15			Not C.	"	A few pairs breed. Most pass north.
Chestnut-sided Warbler	" 11	1	" 20		June 5	Fairly C	"	A few pairs breed. Mostly passing migrants.
Bay-breasted Warbler	" 11	1	" 14			Fairly C	no.	Passing migrant.
Parula Warbler	" 12	S	" 14			Not C.	no.	Passing migrant.
Indigo Bunting	" 12	1	" 20	" 28	Aug 29	C	yes.	
Scarlet Tanager	" 13	10	" 15			Not C.	"	
Warbling Virco	" 13	1	" 14			Not C.	"	
Wood Pewee	" 13	1	" 14	" 17	Sep. 23	C	"	
Wilson's Warbler	" 13	2	" 17			Not C.	no.	
Nashville Warbler	" 15	2	" 16		May 29	C	no.	Passing migrant.
Olive-backed Thrush	" 15	1				Rare		
Sora Rail	" 15	1				Rare		Extremely local.
Mourning Warbler	" 15	1	" 22			Rare		
Black Poll Warbler	" 17	1				Not C.	no.	Passing migrant.
Least Bittern	" 17	1				Rare	no.	
Black Billed Cuckoo	" 19	3	" 20	June 2	Sep. 14	C	yes.	
Cedar Waxwing	" 19	10	" 20	May 20	July 31	C	"	
Brown Creeper				Res'dt.		Fairly C	"	
Night Hawk	" 19	1	" 20		July 29	C	"	
House Sparrow				Res'dt.		C	"	
Pileated Woodpecker	" 20	1	" 25		Sep. 14	Rare	"	
Traill's Flycatcher	" 22	1	" 23			Rare	"	
Cliff Swallow	" 28	S	" 29	May 29		C	"	
Screech Owl	Aug. 2	1				Not C.	"	
Peregrine Falcon	Sep. 19	1				Rare		
Snowflake	Dec. 2	5				Fairly C	no.	Winter visitor.

I have the honor to be, Sir,

Your obedient servant,

MANNING W. DOHERTY.

PART VI.

THE PROFESSOR OF CHEMISTRY.

To the President of the Ontario Agricultural College:

Sir,—I beg to submit herewith my Second Annual Report.

The past year has been a very busy one in this Department. The extension of the course to four years, and the increased number of students in the classes, has made the teaching heavier than in previous years. There has also been a large number of calls for outside work, which had to be attended to, in addition to the investigations mapped out for the year. The sugar-beet experiment and the search made for lime-stone suitable for use in the manufacture of sugar, absorbed a large portion of our time.

W. C. Good, B.A., who commenced upon his duties as Assistant Chemist last January, has rendered efficient service.

Teaching.

During the year, my first endeavor has been to make the instruction given the students of all classes as thorough and practical as possible. My past experience in teaching Chemistry has convinced me that, what a student proves by practical work in the laboratory, he has mastered in a way that no amount of reading and lectures would enable him to do. At the same time, it develops a thoughtfulness and self-reliance that no other method of instruction can possibly give. Fully believing this, I have sought, so far as time and our equipment would permit, to have every student work out each point for himself; and then in the lecture-room, I have endeavored to confirm and develop their conclusions, and by continual reviewing, to keep the whole subject before their minds. In this, I am following up the methods of my predecessor; but I am trying to develop it more and more, especially in the Agricultural and Animal Chemistry of the Second Year. With this Class, I have abandoned the qualitative analysis, and am devoting the time formerly given to it to experiments planned for the purpose of demonstrating the work covered in the lectures.

During the past year, my associate, Prof. Gamble, has taught the Inorganic Chemistry of the First and Third Years, and the Chemistry given to the students of the Dairy School. With some help from my assistant, Mr. Good, I have taught the Organic, Agricultural, Animal, and Dairy Chemistry of the Second, Third, and Fourth Years. The extension of the course for the B.S.A. degree to one of four years has made it possible to give the Agricultural and Horticultural specialists a training in gravimetric work, which gradually led into the analysis of drinking water, fertilizers, fodders, etc. This work was very much appreciated by the classes.

At the request of Mr. Graham, I gave four lectures in January last to the students in the Short Course on Poultry Raising. These lectures dealt mainly with the question of feeding,—the amount and nature of the various constituents forming the ordinary foods, the relative value of these constituents, and the need of combining them in proper proportions, to secure the best results in fattening and in the production of eggs.

For the last two years, all the practical work in Chemistry taken by the members of the Dairy School Class was given in the Milk-Testing Room of the Dairy Building. We have found this very inconvenient in many ways; and, with your permission, I have had part of the basement of the Chemical Laboratory fitted up for this purpose, where, I am sure, better work will be done. This will enable us to give better instruction to the whole class; and, because of the equipment at hand, it will be possible to give more advanced work to those who desire it. The teaching of Dairy Chemistry, together with chemical investigations for the Dairy Department, is an important part of our work, and one which should have a full share of our time. To insure the careful attention it deserves, I have arranged with Prof. Gamble to take charge of this branch of the work. He will also have charge of the Dairy Chemistry taught in the regular course for the B.S.A. degree.

Miscellaneous Work.

Outside of class-room instruction, my work has been very varied. The correspondence has been fairly heavy,—about 900 letters having been sent out in answer to inquiries of all kinds. To answer many of these, considerable laboratory work and reading was necessary.

During the year I have attended the following conventions, for each of which I had to prepare a paper:

Western Dairymens' Association, Woodstock, Ont.
Eastern Dairymens' Association, Whitby, Ont.
Dairy Conference, Ottawa, Ont.
Dominion Master Bakers' Association, Toronto, Ont.

In April, I gave an address on "Flour" before the ladies of the Ontario Normal School of Domestic Science and Art, Hamilton. I have also addressed a number of meetings in connection with the sugar beet industry.

In October, with your kind permission, I attended the meetings of the Association of Official Agricultural Chemists, in Washington, D.C. The various reports and papers read were practical, and exactly on the lines of work in which I am particularly interested; such, for instance, as the analysis of agricultural products. I may say that I have never attended any other meetings from which I received so much instruction and inspiration. In connection with the work of this Association, I was, last winter, appointed Associate Referee on the separation of nitrogenous bodies. At the meeting in October, it was decided to divide this subject into three branches. The sub-division and distribution of the work was agreed upon as follows:

Referee—Dr. Van Slyke, Geneva, N.Y., Milk and Cheese Proteids.

Associate—Dr. Biglow, Bureau of Chemistry, Washington, Meat Proteids.

Associate—R. Harcourt, Guelph, Vegetable Proteids.

I have accepted the position, because the work is important from an agricultural standpoint, and one upon which I have spent some time; and because I consider it an honor and a privilege to be thus brought into direct contact with these men, who are undoubtedly leaders in the line of work which has been allotted to them.

Illustration Plots on Whitby Fair Grounds.

In the spring, I was asked by Mr. G. C. Creelman, Superintendent of Fairs for Ontario, Department of Agriculture, to grow some sugar beets on the illustration plots which the Fall Fair Board had decided to have as

one of the educational features of the so-called "Model Fair" at Whitby, Ont. On consenting to do this, I was further asked to select the most suitable place for the plots, prepare the seed-bed, select the crops to be grown on the various plots, and attend to the cultivation throughout the season. Exactly one-half an acre of ground was prepared, and divided into 40 plots, each two rods long by one wide. After consulting Mr. Zavitz, I selected the following seeds as the most suitable for the purpose:

Clovers:
Lucerne,
Mammoth Red,
Common Red,
Alsike.
Millets:
Japanese Panicle,
Japanese Barnyard,
Hungarian.
Corn:
Mastodon Dent,
Wisconsin Earliest White Dent,
North Star Yellow Dent,
Compton's Early.
Swedish Turnips:
Kangaroo,
Sutton's Magnum Bonum,
Hartley's Bronze Top.
Grasses:
Timothy,
Orchard Grass,
Awnless Brome Grass,
Tall Fescue,
Tall Oat.

Sorghums:
Kaffir Corn,
Millo Maize,
Early Amber Sugar Cane.
Fodders, Forage, and Pasture Crops:
Hairy Vetches,
Common Vetches,
Grass Peas,
Early Yellow Soy Beans,
Medium Green Soy Beans,
Whip-Poor-Will Cow Peas,
Dwarf Essex Rape,
Thousand-Headed Kale.
Fall Turnips:
Cow Horn,
Greystone.
Kohl Rabi:
Early White Vienna.
Marigolds:
Evan's Improved Mammoth Sawlog,
Carter's Champion Yellow,
Carter's Warden Yellow Globe.
Sugar Beets:
New Danish Improved (for feeding purposes).
Kleinwanzlebener (for factory purposes).

The plan of the plot, and the arrangement of the crops, is shown in the following diagram:

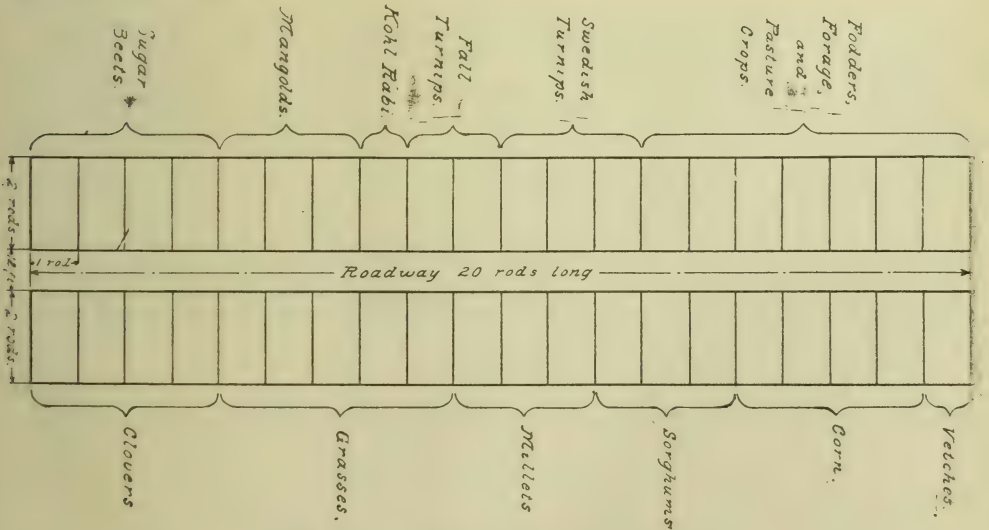


Diagram of Illustration Plots on Whitby Fair Grounds.

To show the sugar beet plants in various stages of development, three plots were selected, upon which the seed was sown at three different dates. These various crops were grown on a very light, sandy soil, which had been

in sod for many years. It was not a very desirable piece of land; but owing to the wet season, and the very thorough cultivation given, under my direction, by Mr. Geo. Stericker, the crops all grew remarkably well, and made a very interesting and instructive feature of the Fair.

Illustration Sugar Beet Exhibit at the Industrial Fair.

Acting on directions from the Minister of Agriculture, I prepared an exhibit of sugar beets for the Industrial Fair in Toronto. The Fair Board kindly placed at my disposal the same space as was used last year, and the same plot of ground, to illustrate the methods of cultivation. The following paragraph is taken from the "Farming World," and illustrates the interest taken in the exhibit:

"The exhibit of sugar beets at the Exposition, made under the direction of the Minister of Agriculture by Prof. Harcourt, was one of the most interesting and instructive exhibits upon the grounds, as was evinced by the large crowds of people who were deeply interested in getting all the information possible from those in charge."

"Immediately outside the building was an illustration plot, in which beets were shown in different stages of growth. Some sown in April had attained their full growth, and were rapidly developing sugar. Some were just ready for thinning and others had recently been thinned. The plot was certainly an object lesson to those not familiar with sugar beets grown for sugar. Inside the building, samples were shown from six experimental sections conducted this year by the Government, under the supervision of Prof. Harcourt. These districts are,—Brantford, Brussels, Guelph, Markham, St. Catharines, and Orangeville. There were samples also shown by the four factories now building, and which will be in operation this fall. The most instructive feature was the exhibit of typical shaped beets alongside of some which had been improperly grown, also the method of topping required by the sugar factories. Beets improperly grown showed fully 30 per cent. waste, while those properly grown had only about 10 per cent. The exhibit of implements used in the cultivation of the sugar beet also attracted considerable attention, and was of great interest to those who think of growing beets next year. Photographs of the Wallaceburg and Dresden factories were shown, also photos of school children thinning beets. The growth of the sugar beet industry has been remarkable in Ontario. Four factories are now under construction, costing over $2,000,000, and it is estimated that nearly $1,000,000 will be paid for beets this year."

Acidimeter.

In the spring of 1901, a circular was issued by the Dairy, Bacteriological and Chemical Departments of the College, offering assistance to all persons interested in dairy work. In this circular, we also offered to supply decinormal alkaline solution at $1.00 per gallon. This solution is used for testing the acidity of cream for churning, and the acidity of milk and whey in the various stages in the manufacture of cheese. At the Dairy Convention, held at Ottawa last spring, the following resolution was passed:

"Resolved that the use of the fermentation test and acidimeter be adopted by cheese and butter makers, and that the Provincial Department of Agriculture be requested to make arrangements to furnish alkali solutions of the proper strength at a nominal cost; also that, as uniformity in the strength of the alkaline solution used in the acidimeter is desirable, the strength of the solution used should be equivalent to ten grams of lactic acid in a litre of distilled water, and that a 10 c.c. pipette should be used to measure the samples."

In accordance with the above request, all solutions sent out this summer have been of the strength recommended. About fifteen gallons of the solution have been sold. The use of the alkaline solution for testing the acidity of milk and whey in cheese-making is gaining favor, and has, with some of our best cheese-makers, almost replaced the hot-iron test.

From time to time, a considerable number of miscellaneous substances have been sent to the Laboratory for examination. Some of these have been analysed; but, in other cases, a few qualitative tests have sufficed to answer all that was required. I have steadily refused to make analyses of soils, unless I knew the samples were properly taken, and that the results

when obtained, would be of value, not only to the person desiring them, but to the Province at large. Acting on the recommendation made in last year's report, I have referred a number of applicants for water analyses to the Board of Health Department in Toronto. We have, however, made a few analyses for Dairymen.

Investigation Work.

Under this heading, I have given a very condensed report of the investigations planned for the year, and the results of such analyses as may b of general interest.

Hamilton Sludge.

Two years ago, a sample of the sludge obtained from the Hamilton Sewage Disposal Works was analysed. The same year, a practical test was made of its fertilizing value. In this experiment, sludge, at the rate of 1,000 lbs. per acre, was applied to a timothy meadow, and increased the yield of hay about four per cent. Dr. Shuttleworth, in reporting on the analysis, said: "I am sure that if this sludge were dried, ground, and applied in sufficient quantities, it would be beneficial to certain crops, as corn, wheat, barley, etc. Applied to land in the form of mud, or in the form of hardened lumps, it might possibly be a physical injury to the soil."

The substance known as sludge consists of solid matter, recovered by certain processes of treatment from the sewage of our larger towns and cities.

The sludge received this year had been dried and ground, and was, therefore, in a much better condition to apply to land. It also contained a little more plant food than that analysed two years ago. The per cent. of nitrogen, potash, and phosphoric acid found in it is given in the accompanying table:

Analysis of Sludge.

	1900	1902
Potash (K_2O)	.097	.14
Phosphoric Acid (P_2O_5)	.380	.59
Nitrogen (N)	.525	.84

These results correspond very closely with those obtained elsewhere. A ton of this sludge contains about the same amount of fertilizing ingredients as a ton of ordinary farm-yard manure, but the plant food is not in so available a form. This is what might be expected; for only that part which is insoluble is recovered in the sludge, and thousands of tons of plant food are annually carried away with the water. The use of water as a means of carrying away the sewage from the houses in our towns and cities is a success from a sanitary standpoint, but it is accompanied by a sad waste of plant food. Many methods have been devised to prevent this waste, but none of them have been really successful.

Fish Food.

At one time, the little brooks and streams throughout the Province were full of speckled trout, which furnished sport and food for the angler. Because of the removal of our forests, and the subsequent drying up of many of these little streams, and the close fishing of the more favorable spots, this fish has almost ceased to live under natural conditions. During

the last few years, sportsmen have constructed artificial ponds, and stocked them with trout, and have replenished the supply in many of the streams in which this valuable fish still remained. What was first done mainly for the anglers' sport, is now being done for commercial purposes; and to-day thousands of these fish are taken from artificial ponds to supply the demands of restaurants in our larger towns and cities. With the growth of this industry, the feeding of the fish has become a problem of economic importance. A little hand-book, published by the Caledon Mountain Trout Co., has the following regarding the feeding of young fish:

"At present, the principal diet is the beef liver, which has been carefully prepared for the infant fish, but it has been found that this kind of food not only affects the color of the flesh and its flavor, but reduces their robust character; the offspring are delicate, and only a small percentage ultimately survive. The expense, moreover, is a consideration, the cost being four to five cents per pound for an unsatisfactory article of diet. Mr. Charles Wilmot has discovered an important change in feeding the young fish by using the eggs of the salmon trout, tons of which he annually collects from the waters of the Georgian Bay, at one-third of a cent a pound. This excellent natural food is not only much cheaper in itself, but the fish retains the natural wild flavor, which is so desirable a quality of this delicious table luxury. Therefore, this is a most successful improvement in fish culture."

In spite of what is said against beef liver in the above quotation, it is used so extensively that it cannot be procured in sufficient quantities to supply the demand. Last July, C. C. James, M.A., Deputy Minister of Agriculture, sent to our Laboratory a sample of food, which was being fed to trout-fish, requesting that the amount of protein and fat in it be determined and compared with that in liver. This food appeared to be simply fish refuse, and the results of the analyses are given in the following table:

Determination of Crude Protein and Fat in Trout Food and Beef Liver.

	Moisture.	Nitrogen.	Crude Protein.	Fat.
	In Original State.			
Trout Food	8.74	12.46	77.88	12.03
Liver	70.59	3.40	21.26	5.02
	In Dry Matter.			
Trout Food	....	13.65	85.31	13.18
Liver	....	11.90	74.37	17.05

The different forms of protein in these two substances were not determined; but, judging from the general analysis, we would say that the trout food possesses a greater food value than the liver. It also contains a greater amount of bone-building material, which doubtless has a special value in the feeding of young fish, as it has in the feeding of young animals.

Water in Butter.

In November, a sample of butter was received, which, upon examination, was found to contain over 53 per cent. of water. This butter had been sold in Toronto, in tubs and crocks, at the regular market price. The person who sent us the butter bought it believing it to be a first-class article. He said, "The tester was put to the bottom of the crock, and the butter withdrawn showed no signs of the excessive amount of water." "There was no water in the bottom of the crock, and the butter turned out leaving the crock clean and dry."

Upon examination the butter was found to have the following percentage composition :

Water	53.15 per cent.	Curdy Matter	1.50 per cent.
Fat	41.21 " "	Salt	4.14 " "

The determination of the volatile acids of the fat showed that the butter had not been adulterated with animal fats, at least not to any appreciable extent. The chief fault to be found with the butter was its abnormally high water content. No doubt it had been treated with one of the so-called nostrums, which have made it possible for the dealer to make a handsome profit in selling water at 20 and 22 cents per pound.

From examinations of butter, made in our own laboratory and at Ottawa, it has been found that the average per cent. of water in creamery butter is a little over 12, and that very rarely does it exceed 15. In this country there is no law fixing the amount of water which may be in butter, consequently there is nothing to prevent such butter being sold. The British Government has recently passed a law whereby butter entering that country containing over 16 per cent. of water is legally considered adulterated.

Does the Amount of Nitrogenous Matter in Butter Affect its Keeping Quality.

This has been a debated question for a long time, and one which has never been definitely answered. In the hope of obtaining some figures that would help to answer the question, we have, during the past summer, determined the nitrogen in a number of samples of butter, churned in different ways, and washed with different quantities of water, and in butter from cream separated in different ways and at various temperatures. The results are given in the following table:

Description of Butter.	No. of samples Analysed.	Average per cent of Nitrogen.	Average score at end of three months. Max. 100
Buttermilk drawn off when butter grains were of "corn" size	9	0.081	Not scored.
Ditto, when grains were of "wheat" size	9	0.076	"
Butter washed with brine	6	0.084	94.
" " water	6	0.085	94.
Butter worked once	4	0.085	Not scored.
" twice	4	0.077	"
" three times	4	0.077	"
Butter made from cream separated at 90 degrees F	3	0.070	92.5
Ditto, at 140 degrees F	3	0.087	92.8
" 160 " F	3	0.091	93.3
" 180 " F	3	0.079	94.75
Milk set in shallow pans	2	0.079	73
Deep setting	2	0.083	87
Bad butter from Guelph groceries	4	0.090	very low.

While there has not been enough work done to prove anything conclusively, these results indicate that the presence of more or less nitrogenous matter in butter does not necessarily affect its keeping quality.

Investigations Regarding the Ripening of Cheese.

For the past two years, considerable time has been given to the study of the chemical changes that take place in the casein, or nitrogenous part of cheese, when cheese is ripened under different conditions as to temperature. As it is not definitely known what compounds are formed from the casein during ripening, no reliable methods for their separation have been devised; consequently, the work on this line has been slow, and the results are not ready for publication.

Some results have been obtained regarding the rate at which curd is rendered soluble when the cheese is ripened in cold-storage, at a temperature of 38 to 40 degrees F., and in the ordinary curing-room at 65 degrees F. Although this work will not be completed for some time, it may not be amiss to give some of the results obtained. The plan of the experiment was as follows:

Two cheese, made from one vat of milk, were placed,—one in cold-storage and the other in the ordinary curing-room. A sample was taken for analysis when the cheese were removed from the press, and once each month throughout the season. A pair of cheese were put away for this work each month from April to November inclusive, but no analyses were made of any of the cheese in September.

In the following table, the per cent. of the total casein that became soluble in water from month to month when the cheese were kept in cold-storage is given under A, and under E the same is given for cheese kept in the ordinary curing-room:

Date of making.	Length of time from making to analysis.	Rate of ripening, as indicated by the per cent. of total case in of cheese rendered soluble.	
		A.	E.
April 28th	30 days	8.0	15.5
"	2 months	11.1	22.7
"	3½ "	13.4	29.2
"	5½ "	31.2	33.0
"	6½ "	28.1	31.2
*May 12th	1 day	2.7	2.7
"	1 month	7.4	14.1
"	2 months	9.2	17.9
"	3 "	11.2	21.8
June 16th	1 day	4.0	4.0
"	1 month	13.5	22.7
"	2 months	16 3	31.8
"	4 "	21.6	36 5
"	5 "	21.6	35.5
July 14th	1 day	3.7	3.7
"	1 month	12.1	22.1
"	3 months	16.5	28 8
"	4 "	18.2	30.1
August 11th	1 day	4.3	4.3
"	2 months	17.4	28.3
"	3 "	18.5	29.7

*May cheese were discarded at the end of three months, on account of developing bad flavor.

Although the same quantities of rennet and salt were used in each month's make, and all other conditions were kept as uniform as possible, notice the much more rapid ripening of June, July and August cheese, as

compared with April and May, both in cold-storage and the ordinary curing-room. With the June and July cheese, kept under ordinary conditions, 22 per cent, of the casein became soluble, whereas only 15 and 14 per cent. respectively became soluble in April and May. It may be said that this rapid ripening of the summer cheese was due to the effect of higher temperature in the curing-room; but the cheese kept in cold-storage, where the temperature never went over 40 degrees F. throughout the whole summer, show the same rapid development.

About the middle of August, the April cheese (A and E) were reversed; A was put into the ordinary curing-room, and E into cold-storage. The effect of this was to increase very rapidly the rate of ripening of A, but there does not seem to have been a corresponding check in the rate of ripening of E. Why, in the case of the April cheese, there should be less casein soluble at the end of 6 1-2 months than there was at 5 1-2 months, is not apparent. The cheese appeared to be moister; but it could hardly have absorbed moisture. Subsequent investigations may throw some light on this point.

Another point worthy of attention, is the rate at which the casein is rendered soluble in the two methods of ripening. Notice that in the April cheese when A was 3 1-2 months old, 13.4 per cent. of the casein was soluble; and that when E was one month old, 15.5 per cent. was soluble. In June cheese, when A was four months old, 21.6 per cent. of the casein was soluble; and when E was one month old 22.7 per cent. was soluble. These, and figures previously obtained, indicate that cheese one month in the ordinary curing-room at about 65 degrees F., will ripen as much as those four months in cold-storage at 38 to 40 degrees F.

The work on these cheese will be continued throughout the winter. In the spring, a cheese will be brought out of cold-storage and placed in the ordinary curing-room. They will be closely watched, and it is hoped in this way to ascertain what effect the changing from a low to a higher temperature has on the quality of the cheese. Upon its completion, a fuller report of this work will be made, in conjunction with Prof. Dean's report on experiments in ripening cheese at a low temperature.

Limestone.

In the process of manufacture of sugar from sugar beets, lime and carbon dioxide are used to precipitate certain solids not sugar in the juice obtained from the beets. The lime and carbon dioxide are prepared by burning limestone in special kilns at the factory. The stone used must be comparatively free from silica and magnesia, because the silica causes what is known as "bridging" in the kiln, and the magnesia clogs the filter clothes and causes trouble in the filter presses. It is, therefore, essential that the limestone used in the factories be almost pure calcium carbonate. The rock of the Guelph formation is dolomite, containing from twelve to sixteen per cent. of magnesia, while much of the rock in the eastern part of the Province contains considerable silica. Both these classes of rock are unsuitable for factory purposes.

During the year, a large number of samples of limestone have been sent to the laboratory for analysis, 42 of which have been analysed. In three quarries, stone of very good quality was found. In a fourth, St. Mary's, the per cent, of silica is high, but otherwise it is good. The composition of the limestone from these four quarries is given in the following table:

Average of Analyses of Samples of Limestone Rock.

	Insoluble matter and Silica (SiO_2).	Lime. (CaO).	Magnesia. (MgO).	Carbon di-oxide (CO_2).
Amherstburg	0.72	54 73	0.29	42.69
Beachville	0.45	54.45	0.49	42.49
Port Colborne	0.96	53.76	1 03	43.08
St. Mary's	2.67	53.18	.81	41.86

The Wallaceburg and Dresden factories are using stone from the Amherstburg quarry; the Berlin factory is using Beachville stone, and the Wiarton factory that from St. Marys.

Test of Different Varieties of Sugar Beets.

In 1900 and 1901, and again this year, the percentage of sugar was determined in a number of varieties of sugar beets grows on the Experimental Plots at the College. These beets were grown only for feeding purposes, but the list included the very best varieties for the manufacture of sugar. The object of the experiment was to determine the yield and feeding value, as judged by the sugar content of the beet; consequently, they were not cultivated as they would have been for factory purposes, but as roots are ordinarily grown on the farm. The only exception to this was that they were sown on the flat. The percentages of sugar in the beet and in the solid matter of the juice are given in the following table:

Per Cent. of Sugar in Beets Grown for Feeding Purposes.

Name of Varieties.	1901.		1902.	
	Sugar.	Purity.	Sugar.	Purity.
Red Top	10 9	81.5	10.2	81.0
Red Skinned	9.6	78.4	13.8	85.2
White Silesian	14.5	86.9	12.5	75.6
New Danish	11.4	81.6	11.4	84.1
Green Top White	13.6	83.2	13.0	84.9
Lane's Improved	11.6	80.9	12.2	84.2
Champion	9.6	74 2	16.3	90.0
Royal Giant	10.4	83.3	9.5	83.3
Giant Red Half Sugar	9.6	85.0	10.2	82.3
White French	14.4	83.5	9.5	80.5
Giant White Half Sugar	9 0	74.7	10.1	81.5
Pitzseheke's Elite	15.8	82.6	14.6	88.9
Jersey	15.6	88.7	12.8	87 7
French Yellow	13.3	85.2	13.0	86 9
Carter's Nursery	16.1	87.6	10.0	80.9
Improved Imperial	16.3	86.4	15.6	90.8
Improved Grey Top	14.9	85.7	15.3	88.6
Queen of the Danes	13.3	84.8	10.3	81 5
Vilmorin's Improved	16.8	88.9	14.4	84.8
Vilmorin's French Sugar	14.0	83.6	16.5	90 3
Mangel Sugar Beet			15.6	87.1
Tancred Cream			9.5	80 0
Jarnsahic Victrix			16.1	89.5
Ideal			7.1	70.6
Dieckman No. 1			16.1	87.0
Dieckman No. 2			16.1	88.5
Dieckman No. 3			16.3	88.5
Rubensamen			16.7	88 3
C. Vorstadt			16.7	89.1
Kleinwanzlebener	17.5	89.8	16.3	90.0

These results should be studied, along with the yield of beets, which will be found in the Report of the Experimentalist, Part XIII. of this volume.

Looking at these results from the sugar-manufacturer's standpoint, the reader will notice that a low percentage of sugar always goes with a low purity, and that high sugar content is associated with high purity. These beets are all excellent for feeding; but, for many reasons, only a few of them are suitable for factory purposes.

Sugar Beet Experiments.

For three years, sugar beet experiments have been conducted on an extensive scale under the direction of the Minister of Agriculture, the object of these experiments being to ascertain the quality and yield of beets that may be obtained from our soil under proper conditions of planting, manuring, cultivating, etc., and, incidentally, to give object lessons in growing sugar beets for factory purposes.

In 1900, these experiments were conducted in the districts surrounding Aylmer, Welland and Newmarket. In 1901, similar experiments were carried on in the neighborhood of Alvinston, Belleville, Berlin, Clinton, Cayuga, Dunnville, Lindsay, London, Mount Forest, Port Perry, Peterborough, Simcoe, Waterford, Walkerton and Whitby. This year, experiments have been conducted in Brantford, Brussels, Guelph, Markham, Orangeville, and St. Catharines. The Renfrew Board of Trade made application to the Minister of Agriculture to have their district included in the list, but at the last moment decided that there was not sufficient interest manifested in it by the farmers to justify them going on with the test.

The general plan of this year's experiments was similar to that of previous years, except that more plots were selected in each district than last year. A four-pound package of seed was given to each experimenter, with instructions to sow it all on one quarter of an acre of land. Every plot was inspected by a competent person to see that the ground selected was suitable and properly prepared, and that the seed was planted at the time and in a manner likely to give the best results. The seed used was an imported German variety, known as the Kleinwanzlebener.

Because the beets must be grown entirely in the ground, and in such a way that they will be forced to mature, we have always insisted that seed be sown on the flat and in rows comparatively close together. The only implement that the ordinary farmer has suitable for sowing on the flat is the grain-drill; and, by closing some of the openings, seeds can be delivered in rows either 14 or 21 inches apart. Owing to the difficulty of working with the ordinary cultivators between narrow rows, we have asked all experimenters to sow from every third spout, thus placing the rows twenty-one inches part. We, however, have found that the drill is not a very reliable implement for this purpose, because, when the ground has been very carefully prepared, the spouts will, even when every precaution is taken, deliver the seed too deep; and if a heavy, dashing rain happens to come before the little plants have made their way to the surface, a thick crust will form, which may prevent the plants from coming up regularly, or may completely destroy the crop. Each year, a number of plots have been wholly or partially destroyed in this way.

It is important that the thinning be done at the proper time, and that the after-cultivation be thorough. To insure this, every plot was visited at

thinning time, and once or twice afterwards. Besides this, two circular letters of instruction were sent to each experimenter.

Between September 17th and 20th, a sample of ten beets was pulled from each plot and sent to our laboratory for analysis. A second sample of twenty beets was taken during the last week of October. At the time the last sample was taken, the beets from 100 feet of a row were pulled, topped, cleaned, counted and weighed. From the data thus obtained, the average weight of the beets and the yield per acre was estimated. The average results of the analysis of the October samples and the average estimated yield obtained in each district, is given in the following table. The average results of all the districts tested in 1900 and 1901 are also given. In figuring the percentage of sugar in the beet from the percentage of sugar in the juice, the factor 93.5 has been used.

Average Results Obtained in the Several Districts Tested.

Districts.	No. of successful experimenters.	Tared wt. of beets in ozs.	Sugar in juice.	Sugar in beet 93-5 factor.)	Purity.	Estimated yield per acre. Tons & pounds.
Markham	37	18.4	16.5	15.4	88.8	17— 63
Brantford	27	14.6	15.3	14.3	87.6	16—1,142
Brussels	30	19.6	15.6	14.5	86.8	14— 441
Guelph	22	16.8	16.2	15.1	88.2	16— 409
Orangeville	29	16.5	16.0	14.9	88.9	14— 476
St. Catharines	44	16.4	15.7	14.6	88.2	16—1,342
Average of 6 Districts, 1902	189	16.6	16.0	15.0	88.1	15—1,646
Average of 15 Districts, 1901	335	....	16.4	15.3	87.5	17— 495
Average of 3 Districts, 1900	116	18.2	14.4	13.4	85.4	16—1,936

The wet, cold weather of the past summer was not considered favorable to the production of beets of a high quality. It was hoped that September would be bright and dry, in order that the beets might have an opportunity to ripen, but even that month proved wet; consequently, it is most gratifying to be able to report such splendid results. From the results secured elsewhere, I feel sure that, owing to the unusually fine weather of the late autumn, sugar beets improved up to the third week of November, and that had we been able to take another sample at that time, we would have obtained even better results.

One point that is particularly worthy of mention in the above results is the purity of the juice. Some of the Western States may be able to produce beets containing more sugar than ours, but nowhere else on this continent have beets been raised that have so high a co-efficient of purity.

The average yields given above are undoubtedly higher than will be obtained where a large acreage is grown. This, I think, is due to the fact that the quarter-acre experimental plots have received more thorough cultivation. It must be remembered that the sugar beet is a highly-bred plant, and, therefore, requires good care and feeding to produce the best results. Without exception, the best results have been obtained where the instructions given have been followed carefully. In the St. Catharines district, 12 out of 44 plots yielded at the rate of over 21 tons per acre, four gave over 25 tons to the acre, and one reached the tremendous yield of 32 tons per acre. These plots were carefully grown by men who are in the small fruit and mraket garden business, and are accustomed to close, thorough cultivation. Consequently, while the yields just cited and the averages of the several

districts are higher than will be obtained this year where large acreages are grown for the factories, they serve a good purpose in indicating what can be grown under the most favorable conditions.

This year, some fertilizer experiments were conducted on a number of plots in the Guelph district. Thomas phosphate was applied to one-half of five different plots. The soil of these plots was very uniform, and had been prepared for roots by fall plowing and manuring. Samples were taken from the part of the plot treated with prosphate, and from the part untreated, once each week for four successive weeks. The following table gives the average weight of beets, percentage of sugar, and co-efficient of purity obtained from five plots at four different dates, together with the average estimated yield per acre:

With Thomas Phosphate.

Date of lifting.	Tared beets in ounces.	Analysis of juice.			Average estimated yield of five plots.
		Brix.	Sugar.	Purity.	
September 17th	18.4	16.9	14.9	88 2	16 tons 178 lbs.
October 8th	14.6	17.3	15.3	87 8	
October 14th	14.6	17.9	16.0	89.2	
October 25th	17.8	18.2	16.3	89.2	
Average	16.3	17.6	15.6	88.6	

With no Fertilizer.

September 17th	18.6	17.7	14.9	84 7	15 tons 70 lbs.
October 8th	12.3	17.4	15.3	87.8	
October 14th	16.8	17 9	15.8	87.8	
October 25th	15.1	18.3	16.3	89.0	
Average	15.7	17.8	15.6	87.3	

The effect of the phosphate has apparently been to increase the average weight of the beets decrease the percentage of solids not sugar in the juice, and thus increase the co-efficient of purity and the yield per acre. The yields were estimated in the same way as in the other experiments.

On four other plots, superphosphate, nitrate of potash, and nitrate of soda were tried alongside of no fertilizer. Samples were taken from each of these plots once each week for four successive weeks, and analysed. The beets grown upon the plots manured with superphosphate gave a slightly higher co-efficient of purity, but otherwise there was practically no difference in quality between the beets from the various plots. In all of the plots, the beets improved from week to week in quality. So far, the fertilizer experiments have not proved anything conclusively, except that the phosphatic manures improve the purity of the juice.

It was felt that much practical value would be added to the experiment this year if a number of the experimenters in the various districts could be persuaded to send their beets to one of the factories now in operation, and thus place the test upon a commercial basis. The Ontario Sugar Company's factory, at Berlin, is the most central, and they very kindly consented to take the beets from our experimenters at the price paid to their own growers, viz., four dollars per ton, delivered at the factory. The special freight rate on beets this year is 50 cents per ton for any distance up to 50

miles, and an increase of practically one cent per mile on each ton for longer distances up to 100 miles. In order that we might get at the actual yields per acre, each plot from which beets were sent was carefully measured. All the beets from this measured area were then placed in a car, divided into as many bins, or compartments, as there were lots of beets to be put in the car. On arrival at the factory, each bin of beets was weighed and sampled for analysis separately, and thus the actual weight of beets and per cent. of sugar in the beet, as determined at the factory, was obtained, and the owners supplied with a cash basis upon which to value their crop. One car, containing the beets from five different plots, was shipped from Markham; two cars, containing twelve lots, from St. Catharines; three cars, containing nine lots, from Brantford; and two cars, containing eight lots, from Guelph. Up to date, the returns on only one car have been received; and it is most gratifying to know that, although the estimated yield of these plots was considerably above the average, the actual returns from the factory give yields which correspond very closely with them. Fuller results of this experiment will be given in a bulletin on the sugar beet work of the year, which is in course of preparation.

It has been stated that the object of these sugar beet experiments is to ascertain the quality and the yield of beets that may be obtained under proper conditions and cultivation. The results of the three years' experimental work prove conclusively that beets of a very high quality can be raised in Ontario, and that large yields can be secured. This is now so well established that capitalists, principally American, have already invested about two and a quarter millions of dollars in erecting extensive plants for the manufacture of sugar from the beet. Four large, expensive factories, with an aggregate capacity of 2,200 tons of beets per day, were built during the past summer, and are now in operation, making sugar for home consumption from home grown material. These four factories are situated at Wiarton, in Bruce Co.; Wallaceburg and Dresden, in the old riding of Bothwell; and Berlin, in the County of Waterloo. Other towns have formed companies, at least two of which are seriously considering the question of establishing factories this next year.

In connection with the cultivation of sugar beets for factories, the labor question has proved a serious one. Owing to the fact that most of the contracts for the growing of beets were not signed until after winter had set in, no special fall preparation was given to the ground; consequently, the farmer started heavily handicapped, and the extremely wet weather of the whole season intensified his difficulty. Some farmers have found to their sorrow that, because the beets are grown so close together, it is not a profitable crop with which to clean a weedy field; others have found that a few acres, well cared for, are more profitable than a large acreage given poor attention. Almost without exception, those men who put in a comparatively small number of acres, such as they could reasonably expect to work properly, have done well and are satisfied with the results. On the other hand, those who put in 75, 100, or more acres have had great difficulty in getting the necessary help, and will have little or nothing left after paying all expenses. The Wallaceburg Sugar Company brought about 70 Belgians from Europe to assist with the work in the beet fields. The Indians of Walpole Island also assisted in the work. The beets for the factories in the Western part of the Province were grown over a comparatively wide area of land, and the scarcity of help was not felt so acutely as it was in the Berlin district. Here a large number of Indians from the Brantford reservation were given employment.

During the pleasant weather of June, it was comparatively easy to get help for the thinning, as school children went to the fields after school hours and assisted in the work. But in the disagreeable weather of October and November, help was scarce; and had it not been for the long open fall, many acres of beets would have been frozen in the ground. They are, however, all lifted, and the factories are now at work slicing them at the rate of nearly 2,000 tons per day, and turning out a fine grade of white granulated sugar. With the experience gained this year, many difficulties will be overcome, and the question of labor will, no doubt, right itself before long.

Considering the inexperience of the growers, and the unfavorable season, the quality of beets going into the factories is good. The question, "Can beets of good quality be raised in Ontario?" is settled; and the question now before those interested is, "Can the farmer raise beets for the money that the factory owners can afford to pay?" This year's experience will go a long way towards settling this question; but another year or two's work is necessary before anything definite can be said. Comparatively few farmers have as yet received their full returns from the factory; but, so far as I have been able to learn from inquiries among them, many farmers have made money this year selling their beets at $4 per ton. All agree that with the addition of 33 1-3 cents for each per cent. over 12, which the Government has set as the price the sugar companies must pay the second year, if they accept the bonus, the raising of sugar beets will be profitable to them. The question now presents itself, "Can the companies afford to pay this price?" If they can, it would seem as though the introduction of a new industry, drawing its raw material from the farm, is assured. If this industry is a success, it will, without doubt, have a decidedly beneficial effect upon agriculture in general; because, as the good results of the thorough cultivation necessary to produce the highest quality of beets are seen in the following crops, it will naturally lead to better cultivation on the whole farm. Thus agriculture in general will be improved by the introduction of the sugar beet industry.

In conclusion, I wish to acknowledge the assistance of the Dairy and Experimental departments in all the work in which we have been associated during the year.

Respectfully submitted,

R. HARCOURT.

PART VII.

THE ASSOCIATE PROFESSOR OF CHEMISTRY.

To the President of the Ontario Agricultural College:

Sir,—I beg to submit herewith a brief Report of my first year's work as Associate Professor of Chemistry.

Teaching.

During the first four months of this year, my time was almost wholly occupied in teaching. To insure thoroughness in the work in elementary Inorganic Chemistry, the first year students of the regular course perform the experiments for themselves, under my direction. This course of laboratory work is supplemented by lectures, in which the experiments are reviewed, observations made regarding the properties of elements and compounds, and accurate conclusions arrived at. In this, my endeavor has been to make the work as interesting as possible, by drawing the attention of the student to the practical application of the Science of Chemistry to Agriculture.

In the third year, students proceeding to the examination for the B.S.A. degree are given more thorough and advanced work in Inorganic Chemistry. To supplement lectures in this branch, we give a three months' course of Laboratory practice in Qualitative Analysis, in which the principles underlying the grouping and separation of the metals are studied carefully.

The Chemistry taught to the Dairy Class is necessarily of the most elementary nature. The object of this course is not to train men to be chemists, but to give the students of the great Dairy Industry a reading knowledge of books relating to their own line of work; to show them reasons for the changes that occur in milk and its products; and to encourage a spirit of inquiry and thoughtfulness. No attempt is made to fit these men for work in the Chemical Laboratory, but each student is given tests for the most common adulterants and preservatives to be found in milk, butter and cheese; and an opportunity is given each member of the class to exercise his skill in detecting and identifying these.

Since the opening of the College, in September, most of my time has been occupied in teaching and in preparing material for class-work.

I am glad to be able to report that the students of my classes have made very fair progress; also that the conduct of the students in the class-room has been excellent.

Investigations Undertaken.

Ash Constituents of Cereals. In the early years of the past century, the attention of agricultural chemists was directed towards the importance of the incombustible or ash constituents which are found in plants. At first it was believed that these existed in the plants merely as stimulants, and were not directly concerned in building up plant tissues. Further investigations, however, proved that the mineral matter entered into the life-giving protoplasm of plants, and was, therefore, indispensable to the existence of plant life. Later, it has been found that, of the different elements which make up the ash content of plants, there are some which are always present in

the ash, while there are some which may be present or entirely wanting without affecting the development of the plant. The former have been termed the essential mineral elements; the latter, the non essential constituents.

The methods of ash analysis used by the early investigators were very crude, but as time passed, numerous improvements were introduced, which made it possible for the analyst to obtain more accurate results. Notwithstanding this, the knowledge of ash analysis is still limited in extent, and there is yet room for much painstaking research.

It was for the purpose of determining the distribution of the different ash constituents in the straw and seeds of some of the cereal crops, and also to determine the total quantity of mineral matter taken from the soil by these crops, that the work herein described was undertaken. In this work, I used a new method of ash preparation, described by Dr. Shuttleworth in the College Report for 1899. It has been claimed for this method that fusion of the ash is prevented, thus reducing the error otherwise introduced in the determination of silica. In my experience in burning barley or wheat straw, no fusion of the ash can be detected; but in the preparation of an ash from a cereal low in silica, such, for example, as oat straw, fusion is not prevented by this method. I am strongly of the opinion that some improvement will still have to be made before absolutely reliable results can be obtained in all cases of ash analysis.

Investigation Proper. The material chosen for this work was barley, the samples used having been grown on the Experimental Plots under natural conditions. The grain and straw were treated separately, in order to compare the distribution of the different constituents throughout the plant. The ash was incinerated, weighed, and the carbon-dioxide determined in a platinum dish of Dr. Shuttleworth's design. This dish has a specially constructed top, which prevents the escape of volatile mineral products. (See College Report, 1899, p. 43).

The subjoined tables record the percentage composition of barley ash, as determined by the new method, and also the results of some previous analyses, which are appended for the purpose of comparison:

Grain.	New method.	Wolff.	Zaeller.	43 Analyses.	
				Lowest.	Highest.
Ash in grain	2.19%	2.23%	2.50%	1.8%	2.8%
SiO_2 in ash	9.6	26.00	31.1	21.1	36.7
Fe_2O_3 "	2.4	.....	.7	.1	2.4
CaO "	4.2	2.7	2.7	.7	4.2
MgO "	12.0	8.9	7.0	4.3	14.7
P_2O_5 "	30.2	34.9	32.4	26.0	39.8
K_2O "	26.5	21.0	18.5	13 8	31.6
Na_2O "	23.6	.....	.....	.....	.....
SO_3 "	1.4	.....	.....	.....	.....
Cl "	1.56	.....	.....	.....	.....
Straw.					
Ash in straw	9.7	4.59	5.0	32.0	5.9
SiO_2 in ash	16.7	50.9	59.7	49.9	68.5
Fe_2O_3 "	1.1	.....	1.9	.2	2.0
CaO "	7.6	7.2	7.3	5.3	13.1
MgO "	4.9	2.6	3.0	1.7	3.11
P_2O_5 "	2.1	4.1	6.0	2.2	7.2
K_2O "	38.5	23.3	12.0	10.8	20.9
Na_2O "	25.2	.....	.....	.....	.....
SO_3 "	.45	.....	.....	.....	.....
Cl "	3.2	.....	.....	.....	.....

It will be observed from the results recorded that the proportion of silica, as determined by the new method, is quite low in comparison with that found by previous methods of preparation and treatment. One-third, and in the case of straw, often more than one-half, of the ash was formerly found to consist of silica. To explain the physiological significance of this mass of so-called silica was extremely difficult. At one time, it was believed that silica was necessary to give rigidity to the straw. This opinion had to be abandoned, however, when it was discovered that the greater part of the silica is stored in the leaves and top part of the stem, showing that it is not there for the purpose of support. It would now seem that there is not nearly so much silica in cereals as was commonly supposed.

Comparing the amount of potash found by the different methods, we notice that the opposite condition of weights exists. The new method, then, gives a high proportion of potash and a comparatively low per cent. of silica. The increase of potash is particularly noticeable in the ash of the straw, which contains the bulk of these two constituents found in the total crop. The results indicate that, with the old method of preparation, a considerable portion of the potash was left in combination with the silica, swelling the quantity of that constituent to undue proportions.

Another noticeable feature of the results recorded in the tables is the apparent lack of uniformity in the composition of ash, as determined by different analysts. The amount of any one element which a plant may contain seems to be a variable quantity. The fourth columns of the tables afford a striking example of variation in the composition of ash. The different amounts of lime, magnesia, and phosphoric acid recorded, which can be determined with perfect accuracy, show clearly that the constituents of the ash vary greatly, even in the same plant. It is evident that the soil upon which the plants are grown, and from which they derive their supply of mineral matter, influences the character of the ash. There must be a minimum quantity of the essential mineral elements provided for the development of plants; it is possible that there is a maximum quantity of each which can be used to advantage by plants; and, further, it is believed that plants can store up in their tissues more mineral matter than is necessary to their growth. This is certainly true in the case of silica, and may be true of other constituents. Just how much of each mineral is conducive to the best development of plants has not yet been ascertained; it is a question which requires further investigation.

Constituents.	Grain.	Straw.	Ratio of mineral constituents in the two parts of crop.
Material	20.320 grs.	34.124 grs.	.....
Total ash	.446 "	3.337 "	1— 7. 5
SiO_2 in ash	.0427 "	.5674 "	1—13. 3
Fe_2O_3 "	.0107 "	.0367 "	1— 3. 4
CaO "	.0187 "	.2536 "	1—13. 6
MgO "	.0535 "	.1635 "	1— 3.06
P_2O_5 "	.1347 "	.0701 "	1— 0.52
K_2O "	.1182 "	1.2847 "	1—10.87
SO_3 "	.0467 "	.0020 "	1— 0.04
Cl "	.0070 "	.1068 "	1—15.33
Na_2O "	.1053 "	.8409 "	1— 8. 0

This table deals with the total weight of the different ash constituents in the crop, and the distribution of these in the straw and seeds. The bulk of the total ash appears in the straw, and, in consequence, the several constituents of which it is composed are also found in larger quantities in

the straw. Phosphoric acid is an exception, the greater part of it being stored in the grain. The distribution of the three elements of the ash,—silica, lime, and potash,—is proportionately greater in the straw.

Calculating from the weights recorded in the last table, when a crop of barley yielding 40 bushels per acre is aken off the land, we find that approximately 136 1-2 pounds of potash and 19 pounds of phosphoric acid are removed with it. If the straw is returned to the soil without the loss of any of its mineral matter, about 125 pounds of potash and 6 1-2 pounds of phosphoric acid are replaced, 11 1-2 pounds of potash and 13 pounds of phosphoric acid being removed in the grain.

Of all the mineral constituents, the two above-mentioned are of most importance to the agriculturist, because of the large quantities of these assimilated by plants and the comparatively high cost of replacing them. The extent to which the soil is robbed of its mineral matter when the crop, and more particularly, the straw, is sold off the farm, is here apparent. There is no practice which will deplete the soil of its ash material more quickly than this. What has been stated regarding barley is true, in a greater or less degree, of the other cereal crops examined, and also of grasses. Meadow hay contains a large amount of mineral matter; and, as the marketable product in this case includes both stems and seeds, depletion of the soil in ash material is very great when the crop is continually removed and sold.

The figures relating to the total quantity of potash contained in a crop of barley greatly exceed former calculations; but, as the crop examined was grown under field conditions, the difference in composition must be attributed very largely to the improved method of ash preparation. The large amount of ash found in the straw would appear to substantiate this opinion.

Knowing these facts, the provident agriculturist will not willfully pursue a course which entails the depletion, and in time the complete exhaustion, of the valuable mineral constituents of his soil, unless he has some means within reach of replacing them. Once removed, they can be replaced only by direct application in some form of commercial fertilizer. This is an expensive operation, and one which requires knowledge and skill to carry it out successfully. Therefore, it appears to be the wiser course for the average farmer to husband the resources already in his possession.

Composition of By-Products of Flour, Oat, Pea and Starch Mills.

During the past few years, a great number of questions have been received by the Chemical Department regarding the composition and relative food values of various by-products from flour, oat, pea, and starch mills. As no systematic investigation of these products had been undertaken in Canada, it was thought well to carry on work along this line. For this purpose, the following circular letter was prepared and sent to the proprietors of all mills in the Province manufacturing such by-products:

"Dear Sir,—We are constantly receiving letters of inquiry regarding the composition and relative feeding value of the various by-products of Oat, Pea, Barley, Corn, and Wheat Mills. To answer these questions with any degree of certainty, we think that a systematic chemical analysis of such products is necessary. For this reason, we are sending out a circular letter to the various milling companies throughout our Province requesting their aid in this matter. We should be pleased to have you send us samples of all the by-products of your mill, together with information regarding the method by which the said products are obtained, and the price per ton at the mill. This information, and the results of the chemical analyses, we propose to embody in a pamphlet for general distribution among millers and farmers. Such information, we think, would be of value to millers, dairymen, and stockmen alike, and, at the same time, would greatly assist us in answering questions such as we have mentioned. We, therefore, hope that you may see your way clear to co-operate with us in this line of work, and, by so doing, you will greatly oblige. Yours truly."

In reply to this letter, some 90 samples have been received. On account of my absence in Europe during the past summer, the analysis of all of these has not yet been completed. I hope, however, to have this work in shape to report upon in the near future.

Humus Soils. The third line of research upon which I am at present engaged, is the chemical composition of humus soils, and the available plant food contained therein. As there appears to be but a vague idea in the minds of many as to what "humus" really is, I beg to be permitted to say a few words in explanation of this term; also to state, in a brief manner, the value of this constituent of the soil to the growing crop, in order to show the importance of this piece of investigation.

The name humus is familiar enough; but to a very considerable extent, it remains little more than a name. We know that soils are composed of mineral matter, in a more or less fine state of division, but mixed with the mineral matter is found also a small amount of organic, or vegetable, matter, which, exposed to the atmosphere, decays; and its constituents, or gases, escape into the atmosphere or become dissolved in the soil water and leach away. This decay of the organic matter involves its oxidation, to accomplish which it is indispensable that there should be a free penetration of air. The oxidation process may be rapid or slow. Under ordinary circumstances, it is slow; but cultivation facilitates it. When, therefore, we expose the soil to the action of the sun, and keep it exposed by continual and intelligent cultivation, we contribute largely to the oxidation of the organic matter. This substance, because it is decaying, is the measure of fertility; but it ceases to be so as soon as oxidation is arrested. This actively decaying part of organic matter constitutes the value of the whole, and it is this part which is really "humus." Therefore, though a soil may contain large amounts of organic matter, unless it be in a soluble state, it is of comparatively little use to the growing crop.

Many prominent agriculturists consider humus as almost the "banking-house of soil fertility;" and, as a matter of fact, the bulk of nitrogen supplied to the plant is furnished by it. It is also the agent in furnishing to the plant much of the mineral matter, that is to say, mineral matter which exists in an insoluble condition in the soil, unites chemically with the humus when present, and becomes soluble, and, consequently, available. According to Ladd: "Of the average total phosphates existing in a number of soils, 41 per cent. of the phosphoric acid was combined with humus; and when the soils were high in humus, the amount of combined nitrogen reached 61 per cent." From these facts, we are led to believe that the chemical value of humus to any soil is very great. Hence, the necessity for some definite knowledge regarding the composition of humus soils. Moreover, as we have noticed, humus is a soluble substance, and, like other soluble materials in the soil, is under a steady waste. It is either dissipated in the air, or leached away in drain water. To reduce this loss to a minimum is the aim of every intelligent and successful farmer. A knowledge of the composition of such soils will, therefore, greatly assist in attaining this end.

In this particular line of work, I have experienced many difficulties, owing to the fact that some of the methods of determining certain of the constituents of such soils, as described in the "Official Methods of Analysis," are not reliable; others are so vague as to lead to endless trouble and annoyance. Mr. de Coriolis, one of our Fourth Year students, is analysing a number of humus soils; and his experience is similar to my own. We have endeavored to remedy one or two of these defects by devising methods which, in our experience, have obviated some of the errors in this line of analysis. These suggestions, I venture to submit.

In digesting, use only three grams of the soil. Start with a very low flame, and allow the contents of the flask to heat for about fifteen minutes. At the end of that time, the danger of frothing is over, and the flame may be raised. Just raise it, however, so that the tip will barely touch the flask. Allow it to boil until the liquid is clear, or of a light straw color. Thirty c.c. of concentrated H_2SO_4 is all the acid needed in this digestion, and should be added to the flask at the beginning. A little pumice stone will reduce the bumping. Take care not to add any water before or during the operation. We found that when we added water to wash down the sediment which had adhered to the neck of the flask, bumping was always very severe. This, in fact, is the "bugbear" of the whole of the process in the determination of nitrogen. After digestion is complete, the usual steps may be followed.

In following the method indicated, it is not necessary to decant the clear liquid before distilling, as the sediment is not heavy enough to make decantation indispensable. If ten grams of soil be used, as directed in the official method, decantation is absolutely essential.

Moisture Determination.

Use ten grams of the soil. Weigh on a tared porcelain dish or watch glass (six centimetres in diameter). Place for ten hours in a water-oven, and keep it at the temperature of boiling water; also keep a constant stream of CO_2 passing through the oven. We have used CO_2 instead of hydrogen gas with marked success. CO_2 is much cheaper than hydrogen, and, because of its inertness, is a very good agent to use in preventing oxidation. We have found it utterly impossible to obtain concordant results, if precaution is not taken to prevent oxidation. We have also found it necessary to heat the soil for approximately ten hours, and never allow it to cool during this time, in order to obtain reliable results in moisture determinations.

The humus soils so far examined have been taken from different parts of the College farm. I hope to extend this investigation to other localities as soon as time will permit. As this work was only recently begun, I shall not venture to report on the results. I would merely say that the figures thus far obtained show wide variations in the composition of humus soils. We are growing crops on these soils in our green-houses, and find that the appearance of the crops corresponds very closely with the results obtained by analysis.

Thus, though a chemical analysis of the soil does not solve all the difficulties which practical men meet with in cultivating soils of low fertility, yet the results obtained afford indications that the inquiry may prove of considerable interest when systematically worked out. We hope to have much information in future along this line.

Before concluding, I wish to thank you for leave of absence during the past summer, by reason of which I was enabled to travel and study agricultural conditions in the old land. I believe that the information gained by visiting the various stations in England and the Continent has been of material aid to me, both in the class-room and the laboratory.

Respectfully submitted,

W. P. Gamble.

PART VIII.

THE PROFESSOR OF VETERINARY SCIENCE.

To the President of the Ontario Agricultural College:

Sir,—Allow me to submit my Report for 1902.

With the exception of materially shortening the course in Anatomy and devoting more time to more practical subjects, the class-room work has been much the same as usual.

First Year. Lectures and demonstrations to this year, during the fall term, consisted in a brief, but comparatively comprehensive, course in Comparative Anatomy, in which the anatomy of the horse received special attention. Where material differences exist between his anatomy and that of other animals, the attention of the class was drawn to them. I also gave to this class a course of lectures on the building of stables, site, material, drainage, ventilation, the kind and size of stalls, both open and box, slope of floors, arrangement of mangers, etc., the general care of horses, in respect to feeding, watering, grooming, exercising, care of the feet, etc.; also the general care of harness and saddlery.

In addition to the above, I gave a series of lectures on judging horses. In this course we were, as usual, handicapped by not having, for purposes of demonstration, fair specimens of the various breeds or classes. I used those we have, supplied some from my own stable, and borrowed some. During the winter term, I delivered a course of lectures on "Veterinary Materia Medica," in which I discussed the general actions of medicines when administered internally or applied externally; the various methods of administering and applying medicines, with the advantages and disadvantages of each. We considered individually the properties, actions, uses, and doses of the drugs commonly used for the prevention and cure of the ordinary diseases of stock.

Second Year. The class-room work for this year, during the fall term, consisted in a discussion of the causes, symptoms, and treatment of the ordinary diseases of farm stock, with frequent reference to the proper methods of feeding, watering, and general care of stock in order to prevent disease. During lectures, I had, as usual, one of my own horses in the class-room, and explained the difference in appearance between a healthy and a diseased animal. When speaking of disease of an external organ, I point out on the healthy animal the seat of disease, and explain the change in appearance produced by the disease. I have specimens of the different diseases of bone, and am thereby enabled to show the class the changes of structure that occur.

During the winter term, I lectured upon Veterinary Obstetrics. In this course, I discussed the general care of females during pregnancy and after parturition, noting the means of preventing and curing the diseases of both dam and offspring incident to the parturient state, and giving special attention to the care of the young. In all cases, when possible, I illustrate these lectures with charts.

A course of lectures or demonstrations called "Practical Horse" was also given. In these I demonstrated with a living horse, the best methods of securing an animal for minor operations, such as lancing abscesses, dissecting out tumors, dressing and stitching wounds, and firing for spavin, ringbone, and kindred diseases; the different methods of castration, dressing teeth, scarifying lampas, administering and applying medicines, passing

a probang in the ox, puncturing an ox in case of excessive bloating, etc.

I also gave a full course of lectures in judging horses, using those we have on the farm and in my own stable, borrowing some, and taking the class to the farms of local breeders.

Third and Fourth Years. To these classes I gave lectures on the various breeds and classes of horses and on judging horses. Some members of these classes competed in the judging classes at the International Exhibition in Chicago last December, and one of them won first place in horse-judging. To the special Dairy Class I delivered a short course of lectures on the prevention and cure of the ordinary diseases of dairy stock.

During the special course in Stock Judging, held in January, I lectured to the classes on judging horses. I take this opportunity of publicly expressing my thanks to the breeders and owners of horses in Guelph and vicinity, who were not only kind enough to lend me their animals, but sent attendants with them to the class-room. I refer particularly to Messrs. Sorby, Bowman, Tovell, Palmer, and Cunningham. In this course, we worked at a great disadvantage in not having sufficient class room for either the class or the animals. This drawback will no longer exist, as the judging pavilion now under course of erection will, doubtless, be completed in time for the course next January. The members of both sections of this class last January expressed in flattering terms their satisfaction and appreciation of the work, and we hope (now that the conditions will be all that can be desired in the way of accommodation, and we have learned from experience more about how to conduct such a course) to be able to make the course more instructive and entertaining, and, hence, more fully to merit the appreciation of the class.

Diseases and Ailments of Stock

In addition to the class-room and practical work mentioned, I gave professional attention to the stock of the Institution. I am pleased to be able to state that the losses were few.

Horses. We had several cases of colic, indigestion, influenza, laryngitis, lymphangitis, colds, sore shoulders, sore necks, scratches, mud fevers, lameness from different causes, etc., all of which recovered.

In January, a vicious mare in the College stable, while in harness, commenced to kick and ran away. The shaft broke, penetrated the abdomen, and wounded the intestines, which protruded, and she had to be destroyed.

In October, an old horse belonging to the experimental department, while in the field at liberty, ran against a wire fence, fell over it, and broke his back, which necessitated his destruction.

Cattle. We had a few cases of parturient apoplexy, a few difficult parturition, several of retention of the placenta, inflammation of the udder, sore teats, impaction of the rumen, bloating, fardel bound, obstruction of the milk ducts, diarrhoea, inappetence, lameness, etc., all of which yielded to treatment. We had one fatal case of lung trouble in a shorthorn bull calf.

Sheep. We had little sickness in sheep, and no losses, except two or three lambs from wool-ball in the stomach.

Pigs. We lost some pigs in the experimental stables from inflammation of the lungs, the cause of which is hard to determine. With the exception of some newly-born ones, this was the only fatality.

I have, Sir, the honor to be,

Your obedient servant,

J. H Reed.

PART IX.

THE PROFESSOR OF DAIRY HUSBANDRY.

To the President of the Ontario Agricultural College:

Sir,—I beg leave to submit my Twelfth Annual Report from the Dairy department. The work done during the year may be classed as follows: Lectures and practical work given to the College students, lectures and practical work given to the special Dairy Classes, experimental work relating to milk, cheese, and butter. The lectures and practical work of the first year relate to Farm Dairying, and those of the second year to co-operative Dairying. The Dairy Specialists in the final year take advanced work, and study three text-books.

Milk and cream to the value of about $1,000 has been supplied to the College during the past year, and our cash revenue will be lessened by about that much.

The Dairy School.

For the three months' course, 88 students registered. During the summer, eight students came for special instruction in butter-making and Pasteurization of milk. For the Creamery Course, in December, thirteen students have registered up to the time of writing. In the Domestic Science Course, 96 ladies registered, in addition to the lady students of the Dairy School. There was a special lecture given by Mrs. Jean Joy, of Toronto, who gave the Domestic Science lectures to the Dairy Class, to the farmers' wives in the locality, which was attended by a large number of ladies from the farm. The total number who registered during the year for special Dairy and Domestic Science instruction was 205.

At the end of the long course in Dairying, 39 students wrote on the final examinations,—27 for the full factory course, three as specialists in butter-making, and nine in the Farm Dairy. All passed their examinations successfully, and those who had factory experience before coming to the Dairy School were granted their Certificates of Standing. Those in the Farm Dairy, with farm experience, were also given Certificates of Standing.

During the year, the following have been granted Diplomas or Professional Certificates:

Butter-making—C. W. McDougall, Grenfell, N.W.T.: H. W. Parry, Compton, P.Q.; D. A. James, Lakelet; J. W. Gibson, Arnprior: J. R. Hutchinson, St. George.

Cheese-making—J. H. Thompson, Laurel; Chas. Atwood, Arkona; J. F. Singleton, Newborough; Carmon Ball, Clarence; Albert Barberree, Quincey. Minnesota, U.S.A.

I take this opportunity of thanking the Instructors of the Dairy School for their co-operation, and especially Messrs. Stratton and McFeeters, for their careful work as Instructors and in carrying on experiments during the summer. Professors Harrison and Gamble, of the College Staff, by their lectures and practical instruction in Dairy Bacteriology and Dairy Chemistry, added much to the profit and interest of the School.

For 1903, we shall continue the features of 1902, and add Instruction in Boilers and Engines, and practical instruction in piping and repairing, a shop having been provided for that purpose.

A special course for those who are, or who wish to become, Instructors will be given in April, 1903, as well as a special summer course of instruction in butter-making, cheese-making, and pasteurization of milk.

Milk for Household Purposes.

The preparation and care of milk for table use has been the subject of considerable discussion during the past few years. The establishment of dairy companies in many of the cities and large towns of Canada has made this subject of live importance. In some places, a great deal of stress is laid upon "clarifying."—a process by which milk is passed through a cream separator, or centrifuge, to clarify or cleanse it. The centrifugal force removes most of the heavy albuminous matter and the dirt which may be in the milk, as it passes through the bowl of the centrifuge. This substance remaining upon the inside of the bowl is known as "separator slime," "separator mud," etc.

In other dairies, pasteurization is considered the proper treatment for milk, in order to prepare it for the table or for other uses as a food. By pasteurization is understood the heating of milk at a temperature between 140 and 185 degrees, and afterwards cooling it.

Some dairies rely upon filters made of sand and cotton, cotton batting, or other filtering material. The filter used by the Copenhagen Dairy Supply Co., Denmark, consists of sand and cotton; while in American and Canadian dairies it is usually made of special cotton batting used for this purpose. The batting is used but once, and then destroyed.

One of the difficulties we met with at the outset in studying this question was to arrange a scale of points for judging the milk treated by the different methods. So far as we know, an exact system of judging milk has never been devised. It was not sufficient for our purpose simply to say that one sample was better than another. We wished to know in what respects it was better. In the first series of experiments, conducted during April and May, the following score-card was used: Smell, 20; taste, 25; acidity, 30; cream, 15; appearance, 10; total, 100.

In the second series, conducted during July, August and September, the scale was changed so as to give more prominence to acidity (sourness). Our reasons for this change were that the sweetness of milk is a very important point in judging of its value for food; and, secondly, that the acidity could be measured exactly, and a correct valuation placed upon it, as expressed by mathematical terms. Our final scale gave 35 points to acidity, and only five to appearance. During the first series, milk containing .1 per cent. or less of acidity was given full points, or 30 out of 100, and each increase of 1-100 of a per cent. of acid decreased the score one point. For instance, milk testing .1 per cent. of acid received a score of 30 points, but milk showing an acidity of .15 scored but 25, and milk with an acidity of .3 or over, received nothing under this head.

In the second series, during which "acidity" received a maximum score of 35, the scoring for acidity was made according to the following scale:

Milk containing less than	.14%	Acid received	35 points
"	.15%	"	34 "
"	.16%	"	33 "
"	.17%	"	32 "
"	.18%	"	31 "
"	.19%	"	30 "
"	.20%	"	28 "
"	.21%	"	26 "
"	.22%	"	24 "

Milk containing less than	.23%	Acid received	22 points
"	.24%	"	20 "
"	.25%	"	18 "
"	.26%	"	15 "
"	.27%	"	12 "
"	.28%	"	9 "
"	.29%	"	6 "
"	.30%	"	3 "

Above .3 per cent. acid, no points were allowed.

It will be observed that in this second scale, each increase of 1-100 of a per cent. of acid in the milk from .15 to .2 decreased the score by one point. From .2 to .25 per cent. of acid, each increase of 1-100 of a per cent. of acid decreased the score by two points; and from .26 to .3 per cent. of acid, the score was decreased three points for each increase of 1-100 per cent. of acid in the milk. It is believed that this scale more nearly represents the commercial value of milk.

In the first series, the milk, previously well mixed in a vat, was divided into six different lots; and, in the second, into seven different lots. Samples were taken in sterilized pint milk bottles for scoring purposes. The samples were marked "normal," "clarified," "Pasteurized at 140 degrees," "clarified at 140 degrees," "Pasteurized at 160 degrees," "clarified at 160 degrees," and, in the second series, one sample was labelled "filtered." They were then placed in a refrigerator at a temperature of about 40 degrees for twenty-four hours, when they were scored the first time, after being brought into a room at a temperature of about 70 degrees for about three hours before being scored. They were then left in this room, except in a few cases where they were returned to the refrigerator, for another twenty-four hours, and scored the second time. The object of doing this was to imitate conditions in a milk dairy, and after delivery to the customers, or consumer. The milk was partly from our own herd and partly that delivered by patrons of our Creamery. The following table shows the average results in both series:

Table Showing the Scoring of Milk Treated by Different Methods.

Series.	Kind of Milk.	Scoring.	Smell. Max. 20 Av.	Taste. Max 25 Av.	Acidity. Max. 30 and 35 Av.	Depth of Cream. Max. 15 Av.	Appearance. Max. 10 and 5. Av.	Total. Max.100 Av.	Per cent Acid. Av.
I. April and May.	Normal	1st score..	13.3	16.8	11.1	14 7	9.6	65.5	.29
		2nd " .	6.4	7.1	0.8	14.5	9.7	38.6	.64
	Clarified	1st " ..	12.2	16.3	12.6	12.6	6.2	59.5	.278
		2nd " ..	7.1	8.2	0 8	12.4	6 0	34.4	.600
	Pasteurized at 140°	1st " ..	16.7	21.3	20.2	13.5	9.0	80.7	.19
		2nd " ..	13.5	16 5	14.7	13.6	9.3	67.6	.22
	Clarified at 140°	1st " ..	14.9	19 0	15.9	12.0	5.9	69.0	.214
		2nd " ..	9.9	11.7	5 6	12.5	7.7	47.6	.342
	Pasteurized at 160°	1st " ..	18.2	22.1	20.9	6.3	8 5	76 3	.18
		2nd " ..	15.8	19.5	19.6	6.1	8.6	69.7	.145
	Clarified at 160°	1st " ..	17.5	21.7	21 5	5.9	7.0	73.8	.222
		2nd " ..	14.6	17.9	19 8	5.7	7.1	65.1	.196
					Max. 30		Max. 5		
II. July, Aug. and Sept.	Normal	1st score..	15.2	15.6	9.1	15.0	4 6	62.1	.397
		2nd " ..	3 0	2.8	0.0	15.0	4.5	25.3	.540
	Clarified	1st " ..	14.5	15.0	10.7	13.0	3.6	56 9	.397
		2nd " ..	3.1	2 4	0.0	13.6	3.8	23.1	.56
	Filtered	1st " ..	15.6	15.3	9.6	14.4	5.0	59 8	.415
		2nd " ..	3.1	2.8	0.0	14.1	4.8	25.0	.54
	Pasteurized at 140°	1st " ..	19.6	24.0	21.3	12.7	5 0	82.7	.228
		2nd " ..	10.6	10 8	8 8	12.4	5.0	47.8	.298
	Clarified at 140°	1st " ..	18.7	22.5	19 2	14.1	3.6	78.2	.225
		2nd " ..	10.3	8.3	7.6	13.8	3 6	43.8	.38
	Pasteurized at 160°	1st " ..	19.7	23.8	27.5	8.0	4.7	83 8	.21
		2nd " ..	12.5	14.5	19.1	7.8	4.6	58.5	.24
	Clarified at 160°	1st " .	19.1	23.8	25 5	7.5	3.7	79 8	.21
		2nd " ..	12.0	12.3	12.3	7.1	3 8	47.8	.266

Comments on Table. 1. It will be noticed that the "normal," "clarified," and "filtered" samples decreased in value very materially in "smell," "taste," and acidity"—at the second scoring. Pasteurizing at 140 degrees and clarifying at 140 degrees gave better results, while the highest scores

in these three points at the second judging were obtained in the lots pasteurized and clarified at 160 degrees. For "depth of cream" and "appearance," the normal and clarified samples lead in both scorings.

2. The highest average first score of the first series was obtained by the lots pasteurized at 140 degrees; the highest average at the second scoring was obtained by the lots pasteurized at 160 degrees.

3. In series II., the highest average at the first scoring was obtained by the lots pasteurized at 160 degrees, although there was not much difference (1.1 points) between the first score of these and of the lots pasteurized at 140 degrees. However, at the second scoring (24 hours after the first), the difference in the score was 9.6 points, showing that the samples heated to 140 degrees deteriorated much more rapidly than those heated to 160 degrees.

Conclusions. 1. For customers, who judge the value of the milk by the depth of cream and by its appearance, normal and clarified milk will suit best, as the pasteurization of the milk prevents the cream from rising, and the bottle of milk does not present so pleasing an appearance. On the other hand, those who desire milk to remain sweet for 24 to 48 hours after delivery, especially if no refrigerator is convenient, and who wish to insure against disease germs in the milk, will find the pasteurized milk much better, especially that heated to 160 degrees. There is, however, a slight cooked taste on the milk heated to 160 degrees, which those unaccustomed to this flavor might find objectionable. The question of the digestibility of pasteurized milk, as compared with that not heated, is one on which authorities are divided, the weight of testimony being in favor of unpasteurized milk. Some recent observations made in New York city would seem to reverse the opinions held formerly regarding the effect of pasteurized milk when fed to infants. The only way to settle this question definitely would be to conduct experiments with pasteurized and unpasteurized milk fed to human beings. Here is an opportunity for some one to make a sacrifice for the benefit of science and mankind.

2. While the scorings do not indicate any advantage from clarifying or filtering, we should not care to say that these were useless. Undoubtedly, a great deal of dirt is removed from milk by running it through a centrifuge, or by filtering through cotton batting, but the benefits of these may possibly have been exaggerated, where care has been taken in producing and handling the milk.

Testing of Cream at the Cream-Gathering Creamery.

The test commonly used at cream-gathering creameries is that known as the "oil-test." In the oil-test, each patron's cream is measured in what is known as a "driver's" pail, which is twelve inches in diameter. One inch in depth of cream in such a pail is known as "a creamery inch." If it tests 100 per cent. of "butter oil," it is known as a "standard creamery inch." The oil is measured in glass tubes, made for the purpose, after the samples of cream have been churned in a test-churn. It is supposed that each "standard creamery inch" will make one pound of butter; but butter-makers have considerable difficulty in making their "oil-tests" agree with the butter actually churned. While the oil-test, in the hands of a skilful operator and with careful cream-haulers, is a fairly reliable test, there is no doubt that the Babcock test is much more accurate.

One difficulty in conection with the Babcock Tester is the fact that it has been considered necessary to weigh each patron's cream, and this has necessitated the carrying of a pair of scales, which is inconvenient, unless

the "spring" balance is used. The spring balance, however, is very liable to get out of order, and is not a legal scale.

Experiments were conducted during the past season to find out the relation in weight of cream, testing from 15 to 40 per cent. fat, to an inch of cream." The cream during July, August, and September was divided at various times into five groups,—Group 1 contained cream testing from 15 to 20 per cent. fat; group 2, from 20 to 25 per cent. fat; group 3, 25 to 30 per cent. fat; group 4, 30 to 35 per cent. fat; and group 5, 35 to 40 per cent. fat.

The table below shows the results of 23 tests:

Percentage of fat in the cream.....	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40
Lbs. cream per creamery inch....	4.19	4.15	4.10	4.10	4.07

It will be noticed that the first group weighed an average of 4.19 lbs. per inch; the second, 4.15 lbs. per inch; the third and fourth, 4.1 lbs.; and the fifth, 4.07 lbs. per inch.

As the percentage of fat increased in the cream, the weight of the cream per inch decreased slightly, as we should expect, because fat is lighter, or has a less specific gravity, than the skim-milk which is so large a part of thin, or low-testing, cream. Owing to the fact that thin cream is more difficult to churn, that it costs more per pound of butter for hauling and for manufacturing, and also because the patron who sends cream with a low percentage of fat is losing valuable food material, we would recommend a standard of 4.1 pounds per inch of cream, and that the cream be measured instead of weighed, owing to the greater convenience.

The drivers may still use their cases and sampling bottles for cream; but, instead of churning them at each time of delivery, as in the oil-test method, these samples may be examined by the butter-maker to note flavor, acidity, etc., then be put in a labelled pint bottle having a preservative made of seven parts of bi-chromate of potash and one part corrosive sublimate. The composite sample may then be tested weekly, once in two weeks, or once a month. Some samples were kept in this way for three months during the past summer, and were successfully tested for fat at the end of that time by the Babcock method. Samples of both sweet and sour cream were treated in this way with good results.

Special cream bottles reading from 30 to 50 per cent. fat, were used for testing. An ordinary Babcock bottle may be used, by first diluting the cream with twice its volume of water, or by using a 6.04 c. c. pipette,—measuring one pipette of cream and two of water into a bottle. Then proceed in the usual way as for testing milk, except that in most cases it is advisable to use slightly less acid than for milk.

If testing of cream for fat contained becomes the method adopted by cream-gathering creameries, then the basis of payment to patrons will be the fat, instead of butter, as estimated by the oil-test churn. This plan is likely to be popular with the patrons, as the price per pound of fat is always greater than the price per pound of butter, because a pound of milk or cream fat will make more than a pound of butter. The increase is usually from twelve to fifteen per cent. in milk, and fifteen to twenty per cent. with cream.

Pasteurization of Milk for Butter-making.

This is a continuation of the work done in previous years. A vat of milk was thoroughly mixed, and one-fourth of it was separated at a temperature of 85 degrees. Another fourth was separated at 140 degrees,

another at 160 degrees, and another at 180 to 185 degrees. Each lot of cream was ripened and churned separately, and the butter was put into cold storage at a temperature of about 40 degrees. This experiment was made in the month of May, and repeated once a month during the next three months. The butter was scored at the end of about one month, again in two months, and again when three months old. The quality of the butter stood in the order of the temperature to which the milk was heated. That made from milk heated to 180 degrees was best in quality, that heated to 160 degrees was second, that heated to 140 degrees stood third, and the butter made from milk heated to ordinary temperature for separating was poorest. These results confirm the experiments of former years; so we shall probably not continue them any further at present.

Conclusion. Butter made from milk heated to 180 to 185 degrees possesses undoubted keeping qualities not obtained by separating at ordinary temperatures, nor by heating to temperatures ranging from 140 to 160 degrees. For export butter, pasteurization of the milk or cream at a temperature of from 180 to 185 degrees is a decided advantage. Pasteurization is also advisable when making butter to place in cold-storage.

Temperature for Ripening Cream.

The best temperature at which to ripen cream has been the subject of much discussion. The work done this past year is a continuation of experiments made in previous years. The temperatures used were 55, 65, 70, 75, and 80 degrees. Altogether 44 trials were made at the different temperatures. The highest average score for flavor was obtained by the butter made from cream ripened at 65 degrees, although there was not much difference in the quality of the butter made from cream ripened at temperatures from 55 to 80 degrees. Ripening takes place more quickly at the higher temperature, and it is probably a question of convenience. The buttermaker who wishes to ripen his cream quickly may adopt a ripening temperature of 70 to 80 degrees with satisfactory results, while he who can control temperature and take plenty of time, have all the conditions favorable for cream ripening, will get good results by ripening at 55 to 60 degrees, but a temperature of 65 degrees has given us, all things considered, the best all round results.

Percentage of Acid in Cream for Butter-Making.

Experiments were conducted during the summer to determine the effects of "high" and "low" acid in cream on the quality of the butter produced from such cream. The lots of cream were divided into four groups, containing .4 to .5 per cent. of acid in the first, .5 to .6 in the second, .6 to .7 in the third, and .7 to .8 in the fourth group. The table shows the average of the first and second scores in flavor, and also the average of these two scorings in each group. The first scoring was made when the samples were two weeks to a month old, and the second a month later.

Percentage of acid in cream.	Scorings of butter for flavor (Max. 45).		
	1st score.	2nd score.	Average of the two scores.
.4 to .5 per cent	42.2	40.5	41.3
.5 to .6 "	41.7	40 8	41.2
.6 to .7 "	42.0	39.6	40.8
.7 to .8 "	41.8	39.7	40.7

Conclusion. There was not much difference in the flavor of the butter in the different groups at the first scoring, but at the second scoring the samples made from cream with high acidity appeared to lose flavor more than those with low to medium acid, .4 to .6 per cent. It is altogether likely that the acid may vary considerably in cream without materially affecting the quality of the butter. For "keeping butter" it is not advisable to have more than .6 to .7 per cent. acid in cream testing 25 to 35 per cent. fat.

Different Percentages of Fat for Butter-Making.

Thirty-two trials were made of cream testing from fifteen to forty-five per cent. fat to determine the difference, if any, in the quality of butter. The average score for flavor in the butter made from cream testing 15 to 20 per cent. fat was 40.8; cream testing 20 to 25 per cent. fat produced butter with a score of 41.0; butter from 25 to 30 per cent. cream scored an average of 40.9; 30 to 35 per cent., 40.6; 35 to 40 per cent., 41; and 40 to 45 per cent., 40.5 out of a possible 45. There was also not much difference in the "keeping quality" of the butters from the lots. The samples made from the thin cream (15 to 20 per cent. fat) lost an average of one point in flavor by keeping one month, while the lots from 20 to 25 per cent. cream lost 1.8 (one and eight-tenths) of a point, and the rich cream lots lost from one to two points in a month by keeping. What difference there was in this respect was not in favor of the butter made from the rich cream, as is commonly supposed, but slightly less acid was developed in the rich cream at churning time.

Conclusion. Here, again, the butter-maker may be allowed considerable latitude as regards the percentage of fat in the cream; but cream having 25 to 35 per cent. fat gives good results, when the conditions are favorable for churning. On the farm, where cream is churned in small churns, from 20 to 25 per cent fat in the cream is satisfactory.

Moisture and Salt in Butter.

This work is a continuation of that done in 1900 and in 1901. The points investigated this year relate to the effects on the moisture and salt content of finished butter: Churned to the size of wheat and corn grains; washing with brine and with ordinary water; working butter once, twice and three times; no salt, salting one-half ounce, and one ounce per pound of butter; draining one hour before salting, and not draining the butter before salting; and working the butter slightly (five revolutions of worker) before salting. The average results are shown in the following table:

Kind of Butter.	Average per cent. of moisture.	Average per cent. salt in	
		Butter.	Drainings from Worker.
Butter churned to size of wheat grains	14 197	3.95	
" " " corn grains	14.182	4.24	
" washed with brine	14.925	3.90	
" " " water	14.858	4.20	
" drained one hour before salting and salted ⅔ oz. per lb. of fat	14.306	3.18	27.54
" not drained, and salted one oz. per lb. of fat	15.155	3.62	30.15
" without salt	13.239		
" salted ½ oz. per lb butter	12.996	1.84	
" " 1 oz. " "	13 562	3 64	
" worked once, 27 revol. worker	12.501	3 65	
" " twice 18 plus 9 revols. worker	12.246	3.31	
" " three times (9 plus 9 plus 9 revols. of worker)	11.759	2.62	
" " 5 revolutions of worker and salted ½ to ⅔ oz.	13.791	3.41	24.80
" " 35 " " " 1 ounce	13.995	4.06	24.92

Conclusions. 1. There was little or no difference in the moisture and salt contents of the butters, whether churned to the size of wheat or of corn grains.

In 1901, the samples churned to the size of corn grains contained the highest percentage of moisture and salt.

2. The moisture and salt in the finished butter was very similar, whether washed with brine or with water. There was also little or no difference in the quality of the butter.

3. The lots drained before salting at the rate of 3-4 oz. salt per pound of fat in the cream, contained less moisture and within one-half of one per cent. the same amount of salt as lots not drained and salted one ounce per pound of fat in the cream.

4. The unsalted samples contained an average of 13.239 per cent. moisture. Those salted at the rate of one-half ounce salt per pound butter contained 12.996 per cent. of moisture, and 1.84 per cent. salt. The lots salted one ounce per pound of butter contained an average of 13.562 per cent. of moisture and 3.64 per cent. of salt.

In 1901, the unsalted butter contained the least moisture, in 1900 the most moisture, and this year it takes a medium position. The results indicate that the moisture content in unsalted butter is not necessarily higher than that in similar butter salted.

5. Butter worked once, twice and three times contained respectively, 12.541, 12.246, and 11.759 per cent. of moisture; and 3.65, 3.31 and 2.62 per cent of salt.

6. Samples worked slightly before salting, and then salted from one-half to three-quarters of an ounce per pound of butter, had 13.791 per cent moisture, and 3.41 per cent. salt; while similar lots treated in the usual way and salted one ounce per pound of butter contained 13.995 per cent. moisture, and 4.06 per cent. salt.

7. The amount of moisture in the finished product is largely determined by the working which it receives. The salt depends upon the amount of salt added, the moisture in the butter at the time of adding the salt, and the amount of working given to the butter.

Exporting Butter in Pound Prints.

We made a small shipment of one-pound and half-pound prints of butter to a firm in Liverpool, Eng., in September. They reported, "Some of the pound packets were absolutely perfect—nothing better could have been desired." "The half-pound squares were very much tasted through exposure of the wood, and some of them were inclined to be a little fishy."

As the shipment of pound and half-pound prints was all from the same churning, and all were packed exactly alike, except for the difference in size of the prints, there could not have been very much difference in the quality of the butter. However, we hope to make some further shipments of butter in pound prints at an early date, and expect better results, as there is a good demand in England for fresh butter, in the form of pound squares, salted one-half to one per cent. of salt. The lot shipped was salted one-fourth oz. salt per pound of butter. We kept one or two prints of the lot in our refrigerator for two months, and the quality was good at the end of that time. No preservative other than salt was used in the butter.

Experiments in Cheese Making

In addition to the experiments herewith reported upon, a good deal of work was done with ripening (curing) cheese in an ice cold-storage at a temperature of about 40 degrees, and, comparing this with similar cheese

ripened in an ordinary room at about 65 degrees. Cheese were also moved from the ordinary curing-room to the cold-storage at the end of one and two weeks, while duplicates were ripened in the ordinary room and in the cold-storage for the ripening period. Other lots were moved from the cold-storage into the ordinary room at the end of one, two and three months to see the effect of taking cheese from cold-storage into a room of much higher temperature. Experiments were also made to determine the effect of a change in the method of manufacturing, in order to produce an increased yield of cheese. A part of these cheese were ripened in cold-storage, and the remainder in an ordinary curing-room. The results of this work are not ready for publication at the time of writing. We hope to have them ready early in the spring, when they will probably be published in bulletin form. I may anticipate the report by saying that, up to the present time, the work confirms that done in 1901, and indicates that a very much lower temperature for ripening cheese may be adopted, with satisfactory results, and with a very much improved quality of cheese. The past season has demonstrated in a very forcible way the value of a cool season for the cheese trade. If we cannot get cool conditions naturally, we must supply them artificially.

Heating Over-Ripe Milk to 110 Degrees at Cooking.

Several trials were made during the summer to note the effects of cooking curds from "over-ripe" milk to a temperature of 110 degrees, instead of 98 degrees, as is commonly done. Fortunately, the season was an unfavorable one for securing "fast working" milk, hence the tests were not numerous enough to warrant us in drawing conclusions of a positive nature. However, the experiments made indicate that for over-ripe milk, this method of heating to 110 degrees would give very good results, especially when combined with washing the curd after milking, to remove the excessive acid in such curds. It was noticed that the flavor and texture of the cheese were better, as a rule, where the curds were heated to 110 degrees; but there was a strong tendency for the curd to mat together at dipping time, after being heated to the higher temperature. The cheese had a tendency to be open, and lacked that closeness which is desired in a well-made Cheddar cheese. Further experiments will be made next year.

Washing Curds.

These experiments are a continuation of those made in 1900 and 1901. The fact that "washing curds" is recommended to cheese-makers as an essential part of the process of cheese-making, is our reason for continuing this work. The experiments this year may be divided into two series: Series I. relates to the effects of washing curds after dipping (a) with a quantity of water, at a temperature of 98 degrees, equal to the weight of the curd; and (b) with a quantity of water equal to twice the weight of the curd, at a temperature of 98 degrees. Series II. was a similar experiment, except that the curds were washed after milling.

In Series I. nineteen experiments were made in July and August, with curds from milk testing an average of 3.7 per cent. fat. The average score of the cheese from curds washed with a quantity of water equal to the weight of the curd after dipping was 90.4 out of 100. Those not washed scored an average of 90.3 points. The loss in weight during ripening (or curing) was 3.64 per cent. on those not washed, and 3.71 per cent on those washed.

Washing with water twice the weight of the curd gave results as

follows : A score of 92.3 and 3.48 per cent. lost in weight, compared with a score of 91.8 and 3.65 per cent. lost in weight while curing, for those not washed.

In the second series, which extended from May to November, nineteen curds were washed after milling, with a weight of water equal to the weight of the curd and the same number were washed with a weight of water equal to twice the weight of the curd. The results were:—

I. All the lots lost about the same percentage, viz., 3.6 in weight while curing.

2. There was practically no difference in the quality of the cheese, whether the curds were washed or unwashed, or whether washed with a quantity of water equal to the weight of the curd or twice its weight of water. The average scores for flavor and total were as follows:—

Kind of Curd.	Av. Flavor. (Max. 40)	Av. Total. (Max. 100)
Unwashed	34.31	89.05
Washed with equal weight of water.	34.42	88.93
Unwashed	35.05	90.10
Washed with twice weight of water.	35.10	89.90

Conclusion. After three seasons of careful work, we find it no advantage to wash all curds, and it tends to cause loss of valuable cheese-making material. It also tends to produce "open" cheese. Curds having a bad flavor or those having too much acid are benefited by washing, but to advise the washing of all curds we consider a mistake on the part of those advocating this method.

Moisture and Salt in Curd and Cheese.

During May, July, and August determinations were made of the moisture in curds at "dipping" and "milling," and of the moisture in green and ripened cheese. The A lots were made with the expectation of retaining an extra amount of moisture in the curd and in the green cheese. Rennet, at the rate of 6 ounces per 1,000 lbs. milk, was used in these lots; most of them were cooked at 90 degrees instead of 98 degrees; and salt was applied at a lower rate, usually one-half pound less of salt per 100 lbs. curd. The lots marked B were treated in the usual way.

The amount of moisture in the curd and cheese and the salt in the green cheese are shown in the following table. This work is to be regarded as preliminary, and we hope to continue it with more cheese next year.

Month.	Variation in method of making.	Average per cent. moisture in				Per cent. salt in green cheese.	Per cent. fat in green cheese.
		Curd at "Dipping."	Curd at "Milling."	Green cheese.	Cured cheese.		
May—							
2 Expts.	A—6 oz. rennet & cooked 94°.	53.582	41.947	34.706	34.500	1 76	....
July—	B—Normal.	52.110	39.899	33.736	33.070	1.82	....
3 Expts.	A—6 oz. rennet	52.189	40.364	33.106	.....	1.48	37.8
Aug.—	B—Normal.	53 084	41.660	33.166	.....	1.48	39.0
2 Expts.	A—6 ozs. rennet, cooked 94°, 2¼ lb. salt.	53.551	43.916	40.768	34.500	1.17	36.4
	B—Normal and salted 2¾ lbs. per 100.	53.396	43.169	37.581	34.07	1.12	37.4
Av. 7 Expts.	A	52.976	41.831	35.752	.....	1.47	....
" 7 "	B	52.895	41.588	34.592	.....	1.47	....

Ripening (or Curing) Cheese in the Dark and in the Light.

These experiments are a continuation of those made and reported upon in 1901. Eighteen different lots of cheese were made between June 10th and July 16th. One-half of the cheese in each lot was put in a well-lighted room, which was at an average temperature during the ripening (or curing) period of 64.8 degrees, and the air of the room contained an average of 81.8 degrees per cent of moisture. The other half of the cheese were placed in a dark room where there was no light except when the door was opened. This room was kept at an average temperature of 64.4 degrees and had 82.9 per cent. of moisture in the air.

The average score of the cheese ripened in the light room was 90.44 points out of 100. Those in the dark room scored an average of 89.94 points. Those in the light room lost an average of 3.76 per cent. in weight during one month, and those in the dark room lost an average of 3.72 per cent. in weight during the same time.

Conclusion : The experiments in both years indicate little difference in the quality of the cheese or loss in weight, whether curd in a well-lighted room or in a dark room. The growth of mould was about the same on both lots of cheese. The results indicate that light makes little difference in the ripening of cheese, so long as the temperature and moisture in the room are favorable.

Coating Cheese with Paraffine Wax.

A revival of interest in coating cheese with paraffine wax led us to experiment further with this method during the past season. In 1896 we reported as follows :

"Excelsior Cheese Coating (paraffine wax) does prevent shrinkage, but the scorings do not indicate any improvement in the quality of the cheese. It did not prevent mould."

In October, two vats of milk, containing about 1,540 pounds of milk each, testing 3.9 per cent. fat, were made into 10 cheese, weighing about 32 pounds each. Two of these were dipped in paraffine wax at a temperature of 180 degrees as soon as taken from the press. Two others were dipped in the wax at the end of one week. Two others were dipped at the end of two weeks; and two others at the end of three weeks. The remaining two were not coated. The loss in weight during one month in an ordinary curing room was nothing for the cheese coated directly from the press. The others lost an average of .78 per cent., 1.57 per cent. and 2.36 per cent. respectively, while the cheese uncoated, lost an average of 3.16 per cent. in weight during one month.

The quality of the cheese is indicated by the scoring, in which the uncoated cheese scored an average of 38 out of 40 in flavor and a total of 93.7 points out of 100. Those dipped when taken from the press scored 35 in flavor and a total of 87.5. Those dipped at the end of one week scored 36 in flavor and a total of 90.5. Cheese dipped in two and three weeks from the press scored 36.5 and 91, and 37.5 and 92.7 respectively for flavor and to-

tal. In the foregoing scores all cheese were scored full (10 points) for finish. The scoring was done by Mr. G. H. Barr, Dairy Instructor, and we asked him to score the finish of the uncoated and coated cheese, which had been kept under the same conditions and without spraying with formalin. He scored the cheese coated at the end of one week, an average of 9.25, those coated directly from the press, 8.5, those paraffined in two and three weeks at 7.75 and 7.5, and those uncoated 6.5 points out of ten.

During August and September, four experiments were made with cheese weighing from 32 to 73 pounds, to determine the effects of paraffining cheese directly from the press and curing in cold-storage and in an ordinary curing-room. The milk used in each experiment varied from 1,254 lbs. to 1,450 lbs. The percentage of fat in the milk used varied from 3.6 to 3.9.

The paraffined cheese lost nothing by curing in cold-storage ; while those coated and cured in an ordinary curing-room lost an average of but .39 per cent. Those not paraffined lost an average of 2.14 per cent. in cold-storage, and in the ordinary curing-room they lost 2.88 per cent.

The cheese which were paraffined directly from the press and placed in cold-storage at about 40 degrees scored an average of 37 out of 40 for flavor and a total of 92 out of a possible 100. Those not paraffined also scored 37 for flavor and a total of 91.3, the difference being in closeness and color in favor of the paraffined cheese. Taking appearance into account, Mr. Barr scored the paraffined cheese 7 out of 10 and the uncoated 4 out of 10.

The duplicates of the foregoing placed in an ordinary curing room, which were paraffined, secored an average of 35 for flavor and a total of 90.1. Those uncoated scored 34.1 for flavor and a total of 88.6. Taking appearance into account, he scored the paraffined cheese an average of 6.1 out of 10, and the uncoated 4.4 out of 10.

Conclusion : Dipping cheese in hot paraffine wax when about one week old prevents loss of moisture and adds somewhat to the appearance of the cheese, but does not prevent the growth of mould. The cheese ripened in an ordinary curing-room and coated with the wax was poorer in quality in one series and better in the other. In cold-storage the quality was slightly better as a result of paraffining. Whether or not it will pay to coat cheese with paraffine wax is a question not settled yet. If paraffining is done the best results are got by coating when cheese are about one week old.

The Dairy Herd.

Our herd at the present writing (Dec. 15th) consists of twelve pure-bred Holstein cows and heifers, three pure-bred Jerseys and three Ayrshires, sixteen grade cows and heifers, six pure-bred Holstein calves, two Jersey calves and five grade calves, making a total of 47 head of cattle. Most of these are young cows and heifers.

It will be noticed that the record of the herd is considerably lower than that of last year. This is probably due to things which we could not control. Three of our best cows had mammitis (or inflammation of the udder) early in the year and were of little use for the remainder of the season. Two of them were sold for beef. The last six cows on the list are two and three year old heifers. We were obliged to change milkers several times during the year, and have had three different men in charge of the herd, all of which has evidently affected the yield of milk and butter. However, we

are hoping for better results next year, and expect to attain a standard of 10,000 lbs. of milk, or 400 lbs. butter per cow.

Record of Herd from Dec. 1, 1901, to Nov. 30, 1902.

Name of cow.	Date when last calf was dropped.	Breed.	Live weight.	No. days milking.	Total lbs. milk.	Per cent. fat in milk.			Total lbs. fat in milk.	Total lbs. butter estimated by adding 15 % to fat.
						Average for year.	Highest test monthly.	Lowest test monthly.		
Marcena	Jan. 20, 1902	Holstein	1,056	326	10,795	3.76	5.00	3.00	401.57	461.57
Twenty	Dec. 13, 1901	Grade	1,122	308	9,587	3.62	4.20	3 00	339.17	390.04
Molly	Jan. 6, 1902	Grade Holstein	1,400	289	8,837	3.75	4.50	3.30	329.03	378.38
Daisy of Rockwood	Jan. 18, 1902	Holstein	1,088	266	8,822	3.39	4.20	2.80	294.77	338.98
Lady Springwood	Feb. 12, 1902	"	1,180	334	7,694	3.32	4 10	3.00	258.88	297.71
Lucy	Mar. 22, 1902	Grade Holstein	1,036	296	7,564	3.50	3.80	3 00	267.64	307.78
Topsy	April 3, 1901	" Short'n.	1,100	302	7,457	4.06	4.40	3.40	297.77	342.43
Dolly	Dec. 4, 1901	" Holstein	1,617	269	7,262	3.50	4.10	3.10	252.19	290.01
Grey	Aug. 4, 1902	" Shorth'n	1,055	244	7,172	3.96	4.60	3 50	278 83	320.65
Polly	June 18, 1902	" Holstein	1,147	285	7,124	3.60	4.10	3.20	252 34	290.18
Mar. Cornelius	Sept. 17, 1902	Holstein	1,409	278	7,112	3.34	3 60	3.20	238 05	273.75
Heidleburg	Feb. 15, 1902	Grade Holstein	1,000	310	6,855	4.15	4.60	3.70	279.47	321 39
Meg	Sept. 14, 1902	Holstein	1,167	229	5,921	3.98	4.50	3.20	228.59	268 37
Emerald Rose	July 28, 1902	Jersey	940	344	5,356	4.57	5.00	4.20	245.64	282.48
Jean III	April 18, 1902	Grade Ayrshire	910	298	5,053	4 37	5.00	3.50	213.89	245.97
Patience	Jan. 3, 1902	Ayrshire	1,000	308	5,052	4.14	5 00	3 20	204.10	234.71
Lilly	Dec. 23, 1902	Jersey	640	283	4,896	4.46	4 90	4 00	215.25	247.53
Bella II	July 18, 1902	Grade Shorth'n	1,042	249	3,824	3.93	4.30	3.60	149.55	171.98
Glen Bessie	Feb. 5, 1902	Ayrshire	932	244	3,593	4.07	4.80	3.60	143.08	164.54
Margaret White	Nov. 16, 1902	Holstein	1,196	226	3,489	3.47	4.20	3.00	129.73	149.18
Average			1,102	284	6,673	3.84	..	..	250.87	289.28

1. The cow which stood at the head of the list last year is again first Her milk yield is somewhat less (584 lbs.) than last year, but her butter record is greater (24 1-2 lbs.). She is a pure-bred Holstein.

2. The second cow for milk and butter production is an ordinary grade cow of no particular breeding. She gave 9,587 lbs. milk and 390 lbs. butter.

3. The milk from each cow was weighed at each milking, and samples were taken for fat determinations with the Babcock tester. The composite samples were tested monthly, and 15 per cent. was added to the fat in estimating the butter yield.

4. The six heifers at the end of the list have lowered the average for the herd, and we shall expect them to do better next year.

Needs of the Dairy Department.

1. A refrigerating plant and small refrigerator in the dairy building for the benefit of students and for improving facilities in our experimental work during the summer time. Ice refrigeration is not suitable for creamery work in hot weather, as the temperature cannot be got low enough and the labor is too great.

2. The sewerage system from the dairy is in need of improvement. I beg leave to recommend that the plot of land west of the dairy buildings be underlaid with sufficient tile to dispose of the sewage by the sub-earth system.

3. The dairy stables need a system of ventilation very badly.

We are indebted, as usual, to the Farm Department for hay, silage, roots and bedding.

All of which is respectfully submitted.

H. H. Dean.

PART X.

THE PROFESSOR OF AGRICULTURE AND FARM SUPERINTENDENT.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to submit herewith my tenth annual report.

The work in lectures covered by my associate, Prof. Cumming, and myself, is fully outlined in the College Circular, and will not be dealt with here. I may say, however, that we are aiming to make our work as practical as possible, and that the short course in stock judging inaugurated last winter, promises to open up a field of great usefulness. Below is given a report of the experimental work and farm superintendence.

Experiments with Fattening Steers.

Roots vs. Silage.

This experiment is a continuation of last year's work. The experiment was commenced with six steers on roots, hay, and meal, and eight steers on silage, hay and meal. One steer in the root group was sick during part of the experiment, so that he has been omitted from the calculation.

The steers consumed, approximately, two pounds of roots for each pound of hay, and two pounds of silage for each pound of hay, in the respective groups.

The roots comprised both turnips and mangels, and the silage was from corn of the Leaming variety.

The experiment lasted from November 22nd to March 21st, a period of 119 days.

Gain in Weight of Steers.	Silage group	Root group.
Average gain per steer in 119 days	210.5 lbs.	213 lbs.
Average gain per steer, per day	1.76 lbs.	1.78 lbs.

The food consumed per 100 lbs. gain, live weight, was as follows :

Root Group: Meal, 453 lbs.; hay, 657 lbs.; roots, 1,394 lbs.

Silage Group : Meal, 432 lbs.; hay, 648 lbs.; silage, 1,321 lbs.

In order to simplify the comparison, we will attach arbitrary money values to the foods consumed, say, meal, $18.00 per ton; hay, $8.00 per ton; roots, $2.00 per ton; and silage, $2.00 per ton. According to this valuation, we get the following:

Cost of 100 lbs. gain in root group, $8.09.

Cost of 100 lbs. gain in silage group, $7.80.

When the roots and silage are valued at the same price per ton, therefore, the silage group made slightly cheaper gains than the root group.

If we assume that the smaller amount of meal and hay required for 100 lbs. gain in the silage group was due to the use of silage, and that the valuation of the hay and meal is a reasonable one, then, according to this experiment, if a ton of roots is worth $2.00, a ton of silage would be worth $2.44. That is to say, in order to make the cost of 100 lbs. gain in the silage group, the same as that of the root group, the following valua-

tion would have to be employed: Meal, $18.00; hay, $8.00; roots, $2.00; silage, $2.44, each per ton. If, however, the meal and hay be valued at a higher price per ton, the difference between the value of roots and silage would be still greater.

In this experiment, therefore, a ton of silage showed a higher feeding value than a ton of roots; and in this respect the result is similar to that of last year, though the difference in favor of silage was greater last year.

Short-keep vs. Long-keep Steers.

In purchasing steers for feeding, it is a perplexing question whether it is better to buy moderately heavy, fleshy steers, which can be made ready for export by February or March, or to buy lighter, thinner steers, which must be kept until May or June. The short-keep steer costs more per pound than the thinner steer; but against this we have quicker returns and less labor, in his favor. Every feeder understands these features of the case; but the relative amounts of food required to produce a pound of gain in the two classes of steers, has never been systematically studied. We propose to study this question purely from the standpoint of the amount of dry matter required for a pound of gain, leaving the question of markets and labor out of consideration for the present.

Of the 13 steers used for experimental purposes during the past year, 7 of the larger and fleshier steers were selected to represent short-keep animals, and were fed with the object of having them ready for market not later than March; and the remaining 6 were fed with the object of marketing in May or June.

The short-keep steers had to be fed a heavier meal ration than the long-keep steers, in order to get them ready for market in time. The average meal rations for the two groups were as follows:

Short-keep Steers: .94 lbs. (nearly 1 lb.) meal per day per 100 lbs. average live weight.

Long-keep Steers: .59 lbs. (nearly $\frac{3}{5}$ lb.) meal per day per 100 lbs., average live weight.

The short-keep steers were fed from November 22nd to March 21st, or 119 days. The long-keep steers were fed from November 22nd to May 15th, or 174 days.

The gains, and dry matter required for one pound of gain, live weight, are given below:

	Short-keep 119 days.	Long-keep 174 days.
Average gain per steer	220 lbs.	289.16 lbs.
Average gain per steer, per day	1.83 lbs.	1.6 lbs.
Dry matter consumed per one pound increase in live weight	16.15 lbs.	13.52 lbs.

Notes.

1. The short-keep steers made larger daily gains than the long-keep steers.

2. It required 2.63 lbs. more dry matter for a pound of gain in the case of the short-keep steers, than in the case of the long-keep steers.

3. In this experiment, the lonk-keep steers had a very marked advantage; but it is unsafe to draw conclusions from a single experiment, and it is intended to make further trials.

Three-year-old Steers vs. Two-year-old Steers.

This experiment is merely an incidental feature of our steer experiments for the year, in which it happened that three three-year-old steers were fed the same rations as four two-year-old steers, and the weights and food consumed are given below:

	Three year old steers,	Two year old steers.
Average gain per steer in 119 days	223.3 lbs.	217.5 lbs.
Average daily gain per steer	1.87 lbs.	1.82 lbs.
Dry matter consumed per one pound increase in live weight	16.95 lbs.	15.74 lbs.

Notes.

A peculiar feature of this comparison is that, while the three-year-old steers made slightly the larger gains, they required more food for a pound of gain than the two-year-old steers.

It is a pretty well established fact that young steers make more economical gains than older ones, and this experiment emphasizes the fact.

Fattening Lambs.

Roots vs. Silage.

Silage is highly recommended for sheep by some feeders, and is held in very low esteem by others. It was thought advisable, therefore, to conduct an experiment with roots and silage for lambs, as well as for steers. For this purpose, 20 lambs were divided into two groups of 10 lambs each. One group was fed roots, hay, and grain, and the other silage, hay, and grain, the hay and grain being the same for each group. Two pounds of roots were fed for each pound of hay, in one group, and two pounds of silage for each pound of hay, in the other group. The lambs were fed 1 1-2 lbs. of mixed grain each per day, in addition to the roots, silage, and hay. The experiment lasted 15 weeks. The gains, and dry matter consumed for each pound of gain, are given below:

	Root group.	Silage group.
Total gain 10 lambs in 15 weeks	318 lbs.	272 lbs.
Average gain per lamb, per week	2.12 lbs.	1.81 lbs.
Dry matter required for one pound increase in weight	11.1 lb.	12.94 lbs.

From the statement given above, it will be seen that in this experiment the lambs fed roots made decidedly larger gains, and required less dry matter for a pound of gain than those fed silage.

Experiments with Swine.

We have had a most unfortunate experience with our experimental swine during the past year. In May we had an outbreak of contagious pneumonia, and before we got it stamped out we had to destroy all the hogs we had on experiment throughout the winter. It also interfered very seriously with our summer work, so that we lost all the work of the winter of 1901-1902, and were able to complete only one experiment during the summer. The experiment is given below.

Feeding on Pasture vs. Pen Feeding.

The main object of this experiment was to test the influence of rape upon the firmness of bacon, when the rape was fed in conjunction with a liberal meal ration. The hogs were about 3 months old when the experiment commenced, July 8th. The outside hogs were first turned upon a half-acre plot of vetches, and three weeks later were given half an acre of rape. They were confined with movable hurdles, and the plot enlarged as they ate off the rape. Altogther, they had slightly over an acre of rape. They were fed dry meal twice a day, which was composed of three parts barley to one part middlings, during the greater portion of the time. As they kept comparatively thin, they were taken into the pens and fed all the meal they would eat during the last three weeks of the feeding period.

The inside pigs were fed in pens, with small outside yards. They were given the same meal ration as the outside ones, and once a day they were fed a small amount of rape, about equal in weight to their meal ration.

There were 18 pigs in the outside lot, and 13 in the inside group.

On November 7th, 10 of the outside hogs and 8 of the inside group were delivered to the Wm. Davis Co., Toronto, where the sides were marked and carefully examined, after they came out of the salt, some three weeks later. Below is the report upon the sides:

Report of the Wm. Davies Co.

"The hogs which you recently delivered to our packing house are now out of salt, and we have pleasure in reporting to you as follows :-

"The bacon from the hogs in both groups was firmer than that in any previous shipment which we have received from you. The sides of bacon mentioned as 'slightly pasty' below, represented only the difference between a very firm side and one which had a slight tendency to softness, but was not in any case sufficient to throw the side in question into the "soft" class.

"Group (1), 10 hogs, 6 sides slightly pasty, 4 of which were from unfinished hogs.

"Group (2), 8 hogs, 2 slightly pasty sides from a rather unfinished hog.

"The writer does not remember at this time the outlines of your feeding test, but the above results show very conclusively that the hogs which you delivered to us produce an excellent quality of bacon."

Note.- Group I. outside hogs; Group II. inside hogs.

From the report given above, it will be seen that the result of feeding rape, as described, was extremely satisfactory, so far as quality of bacon was concerned.

In dividing the hogs for experiment, the strongest and most growthy hogs were selected for outside feeding. The comparison as to the relative

economy of the two methods of feeding is not fair, therefore, to the inside group. Both groups required more meal than usual for a pound of gain, owing, no doubt, to the fact that a number of the hogs were unfavorably affected by the disease which they contracted. The outside hogs required 5.45 lbs. of meal for a pound of grain, and the inside hogs 5.47, so that the two groups were practically even in this respect. If allowance is made, however, for the difference in the two groups at the time of commencing the experiment, the results are decidedly in favor of the inside feeding, for the outside hogs were a much superior lot to begin with.

To sum up: the inside feeding gave rather more economical gains in each of two years, making due allowance for initial differences in groups.

In each of two years, hogs pastured on rape, with a liberal allowance of meal, and hogs fed in pens, with a small allowance of rape, in addition to a full meal ration, gave bacon of excellent quality as to firmness.

There seems to be no doubt that a moderate allowance of succulent food, such as clover, rape, vetches, or roots, has a beneficial influence upon the firmness of bacon.

Farm Superintendence.

Crops.

Meadow. We harvested 90 acres of hay, which averaged a little over two tons per acre. Owing to very wet weather, a good deal of the hay was damaged.

Barley. 12 acres Mandscheuri variety. Sown April 17th, at the rate of 1 1-2 bus. per acre. Commenced cutting July 30th. A good crop, but not all threshed at time of writing.

Cultivation for Barley. Barley followed potatoes. Potato ground was cultivated and ribbed in the fall. In the spring the ribs were harrowed, then cultivated with spring tooth cultivator, harrowed, sown with drill, and finished with Breed weeder. Barley was seeded with grass and clover at the rate of 12 lbs. per acre. Seeds were mixed in proportion of 4 lbs. timothy, 8 lbs. red clover, and 2 lbs. alsike.

Oats. About 65 acres, 12 acres of which were the Liberty variety, and the remainder Siberian. All the oats lodged badly, owing to the wet season, the Liberty being especially bad in this respect. Seeding commenced April 21st, and harvesting August 7th. Oats were sown at the rate of 1 1-2 bus. per acre.

Cultivation for Oats. Oats followed roots, corn, and sod. The root ground was treated the same as the potato ground for barley. The corn ground was plowed lightly in the fall, with two-furrow plows, harrowed twice, and ribbed up for winter. Spring cultivation, same as for barley. The sod was plowed early in September, rolled, harrowed, and subsequently cultivated, so that the sod was fairly well rotted in the fall. Spring cultivation, same as for barley. Oats were seeded with grass and clover mixture, as described under barley.

Winter Wheat. About 20 acres were sown, 9 acres each of Dawson's Golden Chaff, and Early Genessee Giant, and one acre each of Diamond Grit and Michigan Amber. The crop was not sown until September 18th, on account of the prevalence of the Hessian fly the preceding year. The late seeding, however, proved disastrous, for the crop hardly grew enough to withstand the winter successfully. It winter-killed some, and rusted

badly, so that no attempt was made to determine the yield of the different varieties. The average yield was about 20 bus. per acre. It was sown at the rate of 1 1-2 bus. per acre. Between 3 and 4 pounds of timothy per acre were sown with the wheat, and 8 lbs. of clover seed, before the frost was out of the ground in the spring.

Cultivation for Wheat. Winter wheat followed peas. The poorer parts of the field had been manured during the winter and spring before the peas were sown. Immediately after the peas were harvested, the ground was cultivated, harrowed, and rolled, and allowed to lie about two weeks, for the purpose of causing as many weed reeds to germinate as possible. The ground was then plowed lightly with two-furrow plows, harrowed thoroughly and sown with the drill.

Peas. The only peas sown this year were grass peas, of which we had 15 acres. They were sown April 17th, at the rate of 1 1-2 bus. per acre. Owing to the cool, damp season, they did not ripen properly, and were practically a failure.

Cultivation for Peas. Peas followed sod. The cultivation was the same as for oats on sod, except that the ground was manured during the winter and gang-plowed in the spring.

Mangels. 7 acres Yellow Intermediate. Sown May 8th and 10th, in drills 30 inches apart, at the rate of 4 lbs. of seed per acre. Thinned to 12 inches apart in rows. Yield per acre, a little over 800 bus.

Cultivation for Mangels. Mangels followed sod, which was plowed about 4 inches deep during the latter part of August and beginning of September. The ground was rolled and harrowed after plowing, and later, was thoroughly cultivated with the spring tooth cultivator. Manure was applied during the winter at the rate of 15 tons per acre. In the spring, the ground was gang-plowed, harrowed, rolled, gone over with the grubber both ways to thoroughly loosen the lower soil, harrowed again, rolled, and ribbed with a double-mouldboard plow for sowing.

Turnips. 5 acres Hartley's Bronze Top. Sown June 18th in drills 28 inches apart, at the rate of 2 lbs. seed per acre. They were thinned to about 10 inches apart in the rows. Yield per acre, 800 bus.

Cultivation for Turnips. Turnips followed sod, and cultivation was practically the same as for mangels.

Potatoes. 8 acres Empire State. Planting commenced May 16th. The blight seriously affected the yield, which was about 125 bus. per acre.

Cultivation for Potatoes. Potatoes followed sod, and fall cultivation was the same as for mangels, except that manure was applied in the fall, and the ground ribbed up with double-mouldboard plows. In the spring the ground was harrowed down, gang-plowed, grubbed, harrowed, and rolled. Then the double-mouldboard plow was used to open up furrows 28 inches apart, and the potatoes planted 12 inches apart in the furrows. The drills were then split with the plow, covering the potatoes immediately after planting. The potatoes were cut in medium-sized pieces, having, at least, two sound buds on each piece, and the pieces were dusted with land plaster after cutting.

Corn. 20 acres Wisconsin Earliest White Dent, and 10 acres Mammoth Cuban. Planted in hills, 38 inches apart, commencing May 23rd. The wet, cold season was very unfavorable for corn, and the yield was very little over 10 tons per acre.

Cultivation for Corn. Corn followed sod, and the preparation of the soil was practically the same as for mangels and turnips.

Live Stock.

Cattle. Our stock of cattle in the Farm Department comprises the following :

Shorthorns. 1 two-year-old bull, 2 yearling bulls, 3 cows with calves at foot, 4 two-year-old heifers with calves at foot, 3 yearling heifers.

Herefords. 1 yearling bull, 1 cow with calf at foot, 2 two-year-old heifers in calf, 1 bull calf.

Aberdeen-Angus. 1 bull, 1 cow with calf at foot, 1 two-year-old heifer, 2 yearling heifers.

Galloways. 2 cows, 1 heifer calf.

Holsteins. 1 bull, 3 cows.

Ayrshires. 1 bull.

Jersey. 1 bull.

Steers. 21 feeding steers.

Sheep. Small flocks of Shropshires, Oxfords, and Leicesters are kept.

Swine. Our breeding operations are restricted to Yorkshires, Tamworths, and Berkshires, of which the Yorkshires are the most numerous, owing to the greater inquiry which we have for this breed.

General Notes on Feeding and Management.

As a rule, though sometimes circumstances compel us to depart from it, the bulky part of our ration for cows, steers and young cattle, consists of a mixture of pulped roots, silage and cut hay, mixed about a day in advance of feeding. We think there is less waste of hay with this method. For bulls, our bulky ration is usually turnips and cut hay. The meal ration varies with circumstances. Oats and bran constitute our favorite ration for bulls and growing stock, and from one to two pounds of oil cake per animal per day is usually fed in addition. The quantity of meal varies with what we regard as the requirements of the case. There is little danger, however, of hurting an animal with oats and bran. The steers are fed almost anything that is available in the way of meal. We like to use considerable corn in their meal ration, when we can get it worth the money. Peas, barley, wheat and some oats are also used. Steers which are to be kept until May or June get very little meal before the middle of December, and then only 4 or 5 lbs. per day. They are gradually increased after this, according to their condition, though we seldom exceed, on an average, half a pound of meal per day per hundred pounds live weight of the steers. Steers intended for market in February or March are fed more heavily, beginning with about one-half lb. meal per day per 100 lbs. live weight, and gradually increasing, though we seldom reach a pound of meal per day per 100 lbs. live weight of the steers.

In winter our sheep subsist mainly upon mixed clover and timothy hay and pulped turnips, a full grown sheep being allowed about 4 lbs. of roots per day. Lambs receive a ration of oats and bran in addition, and the ewes are also allowed a light grain ration for a month or six weeks before lambing.

The swine receive a variety of foods. We get a large quantity of kitchen refuse from the college kitchen, and practically all the hogs are given a share of this. To a large extent, the kitchen refuse takes the place of roots. Our grain ration is principally barley and middlings, or barley, wheat and middlings. Sometimes a few oats are included in the mixture. For small pigs, we find a mixture of one part barley to three parts middlings to answer very well. The proportion of barley or other grain is usually increased as they grow older. Breeding sows are usually fed more oats in their ration, and the meal ration is limited, except when suckling pigs, at which time they are fed liberally. Roots and kitchen refuse are fed in considerable quantities. In winter, breeding animals are given exercise in a shed built for the purpose, and for the summer a pasture lot has been provided. For pasture, we are using vetches and rape. This green food is also cut and fed to pigs in the pens or paddocks during the summer.

Financial Matters.

In previous years an attempt has been made to show the various credits and debits of the Farm department, but it has always been a very unsatisfactory undertaking. The Farm department supplies other departments with various products, such as hay, silage, roots and pasture for the herd in the Dairy department; hay and roots for stock in the Experimental Feeding department; potatoes to the College boarding house; hay and grain for eight or nine horses belonging to other departments; besides assisting other departments in various ways with men and teams. These things might be estimated with a fair degree of accuracy (though it is very difficult always to draw the line between the farm and other departments, owing to their dependence upon one another); but the Farm department has to supply stock for educational purposes, and it is impossible to value this work in dollars and cents. Further, the appropriations for the Farm and Experimental Feeding departments are not kept separate, and I find it impossible to obtain a separate statement of the expenditure of each one. Since it is impossible, therefore, to give a statement which would be absolutely fair and accurate, and since no special purpose could be served by a separate financial statement of the Farm department outside of the general financial statement of the institution, I have taken the liberty of omitting this usual feature of my report. Trusting this will meet with your approval,

I have the honor to be,

Your obedient servant,

G. E. Day.

PART XI.

THE PROFESSOR OF HORTICULTURE.

To the President of the Ontario Agricultural College :

Sir,—I have the honor of presenting herewith my tenth annual report on the work of the Horticultural department.

In looking back over the work of the year, we nearly always experience a feeling of regret that, in a field such as ours, which offers such limitless opportunities for good work, more has not been accomplished. Yet we have good reason for assurance that we have not labored in vain; for, although our efforts have necessarily been spread over too wide a field to make very marked advancement in any particular line of the work, still we know good steady progress has meen made in most, if not all. What we most urgently need is more men and more money, if we are to make the advancement we desire, and which is expected of us.

Instruction of Students.

As the regular courses of instruction in this department are fully outlined in the Circular, and as the scope and methods of teaching were fully outlined in last year's report, I shall refer briefly to only two branches of the work under this head.

Floriculture. Floriculture is a subject upon which in recent years there has been a keen and constantly growing demand for information, both by town and country people. The methods we have adopted of enabling our students to gain this information is, we think, the proper one, considering our conditions. When the College opens in the fall, the students begin observing and studying the specimens still in bloom in our large borders of annuals and perennials; and before they leave in the spring they are given a collection of seeds gathered from these borders during the summer, with which to start similar ones at their own homes. During the winter the students are required to become as familiar as possible with the different kinds of plants in the greenhouses; and the methods adopted to keep them in a thrifty, vigorous condition. After some practice in methods of propagation, they are allowed to propagate for themselves a collection of those kinds known to be the most satisfactory for home growing. This plan has stimulated a great interest in the work, and nearly every member of the class upon leaving the College last April took with him a choice collection of house plants of his own propagation.

Forestry. For want of a better arrangement, the subject of forestry has been attached to the department of Horticulture. We have been doing our best with it, but cannot begin to give it the time and attention which its importance demands. What is needed is a well-trained man, who can give his whole time to it; one who can give our students a good practical training, and who could not only begin the much-needed work of re-foresting a considerable portion of the College Farm, but could also encourage and assist in this work throughout the Province. The increasing interest in this subject of late years well warrants such an appointment, and we trust it will not be long in coming.

Correspondence.

One of the ever increasing duties of the heads of departments here is the attention to correspondence. Nearly every mail brings letters inquiring about the best varieties to plant; the best time and method of pruning; what fertilizers to use; and a hundred and one other such questions relating to all the varied branches of horticultural work. To answer all of these personally takes much time, and often careful research, yet we believe that in no other way could the various departments here render better service to the public. The appointment of a departmental stenographer and typewriter has very much relieved us of the clerical part of this work, and we are glad to give in this way all the information we can to those who desire it.

Conventions Attended.

The following conventions were attended during the year, and addresses were given as mentioned:

The Provincial Fall Fairs' Association, Toronto, Feb. 19th and 20th, where I spoke on "The Fall Fair as a Horticultural Educator," and presented a model prize-list for the adoption of Fall Fair Boards.

The Canadian Horticultural Association, Hamilton, Sept. 3rd and 4th, where I spoke on "The Relation of the Professional Florists to the Local Horticultural Societies."

The International Plant Breeders' Convention, held at New York, Sept. 30th to Oct. 2nd.

The Ontario Fruitgrowers' Association, held at Walkerton, Dec. 1st to 3rd, where I gave an address on "The Growth and Development of Fruiting Branches in Our Common Fruits," and presented the Report of the New Fruits' Committee on the New and Seedling Fruits of the Year.

The Ontario Agricultural and Experimental Union, Guelph, Dec. 8th and 9th, where I presented a report on our Co-operative Experiments with Small Fruits, and a report as Treasurer of the Experimental Union.

Bulletins, Reports and Articles Published.

In connection with Prof. Reynolds, of the Department of Physics, a bulletin was published giving the results of some of our experiments with apples and pears in cold-storage.

In the Nature Study Bulletin, published by the Department of Agriculture, I prepared "The Story of the Apple."

For the Fruit Experiment Station Report, I prepared a report on my annual inspection of the stations.

For the Ontario Fruitgrowers' Report, I prepared a report on the seedling fruits of the year.

For the Experimental Union Report, I prepared a report on our Co-operative Experiments with Small Fruits.

For the Report of the Secretary of the Fall Fairs' Association, I prepared model prize-lists for the adoption of Fall Fair Boards, on Fruits, Flowers and Vegetables.

Besides numerous questions answered in the Farmer's Advocate and Canadian Horticulturist, the following articles were contributed to the public press:

First Lessons in Fruitgrowing. No. 1, Tree Roots; No. 2, Tree Trunks; No. 3, The Growth of Trees; No. 4, The Tree Top and Branches; Observa-

tions on Buds; Some Peculiarities of Fruit-spurs; Lessons on Leaves; Study of Fruit Blossoms; Fruit Prize-lists; The Fall Fair as a Horticultural Educator (Canadian Horticulturist); Address to the Canadian Horticultural Association; The Co-operative Testing of Small Fruits in Ontario (Montreal Star); Seedling Peaches in Guelph (Guelph Mercury).

Inspection of Fruit Experiment Stations.

During the summer I visited ten out of the fourteen of our Fruit Experiment Stations. These visits were made, as far as possible, at the most opportune time for seeing what was being accomplished. Note was taken of what progress is being made, and a number of photographs were taken at each station, to illustrate some of the most important features of the work.

I am glad to say that these stations are now doing excellent work, and the results obtained are of great value to the people of this Province. A full account of this work, and my report on the inspection of the stations, will be found in the Report of the Fruit Experiment Stations.

Co-Operative Experiments.

In connection with the Experimental Union, we have, during the past nine years, been carrying on a series of co-operative experiments with small fruits. At first these experiments were confined to about half a dozen counties and sixty experimenters. Now they have found their way into every county and district in the Province, and a few are being carried on in each of the other Provinces of the Dominion. We have now on our books the names of over 1,200 experimenters engaged in this work.

The following figures give some idea of the extent of the distribution of plants during the time we have been engaged in this work. During the past nine years we have sent to experimenters: 2,832 currant bushes, 3,596 gooseberry bushes, 4,368 blackberry bushes, 5,592 red and white raspberry plants, 5,688 black raspberry plants, and 31,872 strawberry plants—making a total of 53,948.

The valuable features of this work might be briefly summed up as follows:

1. Through the plants distributed, many get a start in the growing of small fruits, who probably never would have made a start otherwise.

2. The concise, cultural directions sent out with each lot of plants enable beginners to adopt the right methods of cultivation from the beginning.

3. The varieties distributed are those which have been found, by repeated tests at the College, to be most likely to prove satisfactory with the experimenter.

4. From the plants sent out, each experimenter may soon propagate for himself enough plants to set out a large plantation.

5. The experience and information gained in properly planting, cultivating, cropping, weighing, recording, and reporting the results, with one of these simple experiments, is an education in itself of value to anyone, young or old.

Experimental Work at the College.

For several years past we have been conducting extensive variety tests with strawberries, raspberries, gooseberries, blackberries, currants, and tomatoes, and much valuable data have been accumulated, a brief summary of which is presented from year to year in this annual report.

Tests are also under way with the larger fruits, such as apples, pears, plums, peaches, cherries, quinces, and grapes.

Apples.

In the young orchard, set out six years ago, quite a number of the earlier bearing varieties are now coming into bearing; and we are finding that, as is often the case, many of the varieties are not true to name, and will have to be grafted over to the proper kinds. In a block of thirty Talman Sweet apples, that were planted for top-working, we have been adding a number of new varieties by top-budding. This plan of top-working has proved very successful, and many of the buds have made a growth of two and three feet the first season after the branches are headed back.

The following varieties fruited heavily his year on young trees six years planted: Ben Davis, Duchess, Gano, Gideon, Longfield, Ontario, Wagner, and Wealthy. All of the crab apples, viz., General Grant, Hyslop, Martha, Montreal, Transcendent, and Whitney, also bore heavily.

The following have begun bearing and bore a light crop this year:

Alexander, Benoni, Baxter, Bottle Greening, Cooper's Market, Duchess of Oldenburg, Fallawater, Haas, Hubbardston, Hare Pipka, Hurlburt, Malden's Blush, Magog Red-streak, Peter, Shackleford, Stark, Talman, Trenton, Utter's Red, Walbridge, and Wellington.

Pears.

Pears have, on the whole, not done so well as apples, and many of them appear to be having a struggle for existence in this climate. The Bartlett has been doing well as a dwarf. It began fruiting two years after planting, and all of the trees bore a nice crop this year.

The following varieties, grown as standards, began fruiting this year: Bartlett, Easter Beurre, Flemish Beauty, Giffard, Keiffer, Lincoln, Lawrence, Manning's Elizabeth, and Seckel.

Plums.

The plum trees have made a very fair growth; and of the American varieties, the following bore a fair crop this year: De Soto, Hawkeye, Weaver, and Wolfe.

Of the Japan varieties, the Abundance and Burbank have both been fruiting for two or three years. The latter are by far the most vigorous growing and most productive trees in the orchard.

Of the European varieties, the following have begun fruiting: Beauty of Naples, Field, Grand Duke, Lombard, Monarch, McLaughlin, Reine Claude, Smith's Orleans, Shropshire Damson, and Victoria.

Cherries.

There are about thirty varieties of cherries in our collection, and most of the sour varieties, such as Early Richmond and Montmorency, made a very satisfactory growth, and have been bearing for the past two years.

Quite a few of the sweet varieties have made a fair growth, but a number of them are showing signs of being too tender for this section. A few have begun fruiting, but the crop has been light, and so scattered that the birds usually pick it all before we get a chance to secure any of it, or make a record of its quantity.

Peaches and Quinces.

We have included in our test of the tender fruits, ten varieties of peaches and three of quinces. For the first year or two, these trees were given winter protection by wrapping the trunks and tops with straw and corn-stalks, but last winter they had no protection, and although the ends of the quince branches were more or less killed back, yet all of the trees survived the winter. Of the peaches, Barnard's Early, Crane's Early, and Fitzgerald bore a fair crop this year.

In and about the city of Guelph a great many peach trees bore a large crop of fine fruit this year. We examined specimens of the fruit from about thirty seedling trees, one-third of which might be classed as first-class varieties. We have secured pits from nearly all of the trees producing the best fruit, and intend to grow seedling trees from them under our more exposed conditions. If we can in this way raise a variety of greater hardiness, without losing any of its good qualities, we will have obtained a much desired result.

Strawberries.

For the past seven years we have been conducting an extensive variety test with strawberries, and during that time have fruited nearly 300 varieties. Careful notes have been taken upon the habits of the plants, and the character of the fruit of each variety, and every picking has been carefully weighed and recorded. In this way, much valuable data have been obtained, but only a brief summary of the results can be presented in this report. We have been frequently asked, "Well, after all your testing, which is the best strawberry?" This is a question too indefinite to be answered satisfactorily. If we were asked, which is the most productive berry; the largest berry; the best table, or canning, berry; the earliest, or the latest berry—the answer would be much easier; for there are many desirable characters in a strawberry, and so few varieties that possess more than one or two of these, that such a question cannot be answered without knowing what characteristics are most desired.

In the following paragraphs we will mention a dozen of the most desirable varieties that have been under test. This list includes one or two of the newer ones, which have been fruited for the first time this year, and a number of the older ones that have made a record for themselves, after several years of trial. The planter may select from these a half dozen of those most likely to suit his purpose, and no grower should be content with less than half a dozen varieties of strawberries. Among the leading early varieties are: Van Deman, Wesley, Sadie, and Splendid.

Van Deman has been fruiting here now for seven years, and although somewhat lacking in vigor of plant, and while not so productive as any of the others mentioned, yet it is one of our choicest very early varieties, being of fair size, firm, and a beautiful dark rich color.

Wesley has been fruited for five years. It is a very vigorous, pistillate sort. The fruit is rather small, but ripens early, and is produced in great quantity.

Sadie also has been fruited here for five years. It is a vigorous grower, and a good pollenizer for early pistillate varieties. This variety has not only proved early, but very productive. The fruit, however, is not nearly so large as that of Van Deman; but it is plump, firm, and of good quality.

Splendid is one of the old varieties that has been fruited here for seven years. It is a vigorous grower, with perfect blossom. The fruit is of fair size, firm, and of a good color. On the whole, it is not so early as Van Deman, but it is much more productive.

Among the leading midseason varieties are: Clyde, Warfield, Williams, Tennessee Prolific, and Parson's Beauty.

Clyde has been fruited here for five years, and has proved to be one of the best yielders in the lot. This year it ranks fourth on the list, but for the average of five years it easily ranks first. The plant is vigorous and healthy, and is a good pollenizer. The fruit is very large, smooth, and regular in form; only moderately firm, but of too pale a color to make a first-class berry.

Warfield is one of the old standard varieties. It is a wonderful plant-maker, and on moist soils, or in favorable seasons, is one of the most productive; but it will not stand drought or dry soils. The fruit is uniformly of medium size, firm, of a very dark rich color; and being so easily hulled, it is one of the favorite varieties for canning. The past season, being a showery one, our crop of Warfields was unusually fine.

Williams and Tennessee Prolific have been fruited here now for seven years. Both are vigorous growers and have made good records for productiveness. The Williams is probably one of the best known berries throughout the country, and is deservedly popular because of its adaptability to varied soils and conditions. The berries of both varieties are large and firm, and in most respects are very much alike, except that the fruit of the Tennessee has not the green tip, which is one of the worst faults of the Williams.

Parson's Beauty is a new variety which fruited here for the first time this year, and headed the list in yield. It is very unusual that a variety makes such a record the first year of its introduction. The plant is vigorous and healthy, and the blossoms perfect. The fruit is large, not quite so smooth as might be desired, but firm, and of good color. This is certainly a very promising market variety, and we shall watch with interest its behavior in the future.

Among the most desirable late varieties are: Irene, Saunders, and Buster.

Irene has been under test for five years, and has made an excellent record for productiveness. The plant is vigorous and healthy, and the blossoms are pistillate. The fruit is of medium size, and retains its size well to the end of the season. It is firm, and of that dark rich color so much desired for canning.

Saunders is, in many respects, like the Williams, and has made a good record here during the past seven years that it has been fruited.

Buster has been under test for five years, and has made an exceptional record for productiveness. The plants are very large and are vigorous and healthy; and the blossoms are pistillate. The fruit also is very large, but light in color, and not firm enough for distant shipment.

With a view to ascertain the rate at which strawberry plants naturally increase by runners, seventeen of the standard varieties were selected, and six plants of each were planted at the usual time in the spring, 3 feet

apart in the regular rows, which were 4 feet wide. They received the same treatment as plants grown in the regular way, and all of the runners were allowed to set. In the following spring the number of plants set of each variety was counted, and the figures below give the average increase of runners per plant:

Jocunda, 23; Anna Kennedy, 30; Irene, 31; Haverland, 31; Van Deman, 32; Fountain, 32; Glen Mary, 37; Clyde, 38; Wm. Belt, 41; Warfield, 42; Buster, 47; Burt, 48; No Name, 51; Standard, 53; Wesley, 56; Ruby, 85; Sadie, 100.

This gives an average increase for all varieties of 45 plants per plant set, and it shows how quickly one may get a large stock of these plants from a small beginning.

Raspberries.

In our experimental raspberry plots there are now over 60 varieties. They are set in rows six feet apart each way, and our records are based upon the results of six hills, of six canes each, of each variety. As with the strawberries and all other small fruits, each picking is carefully weighed and recorded. In summarizing the results, it may be said that the results this year tend largely to confirm those reported in previous years.

Columbian again heads the list for productiveness, and his year it gave nearly double the yield of Shaffer, which it much resembles. Both of these varieties belong to the purple-cane family, and propagate by rooting of the tips of the canes. The fruit is of a dull red or purple color, excellent for home use, but not attractive enough for a market berry.

Loudon, Cuthbert, and Marlboro' still rank among the best of the bright red fruited varieties. All of these propagate rapidly from suckers, and they rank in the order named for total yields this year. Marlboro' is a week or ten days earlier than Cuthbert, while Loudon is somewhat intermediate between the two. All produce large, firm, handsome berries, which make a good appearance in the market.

Black Raspberries.

Twenty-five varieties of black raspberries are now under test in our experimental plots, about half of which have been fruiting for the past six years. This fruit seems to be one of the most variable in its yields from year to year, and often the variety producing the largest yield gives the smallest berries. In mentioning a few of the best, we have to take into consideration, therefore, the size and quality of the berries, as well as the productiveness of the bush. The following may be mentioned as a few which, on the whole, have proved most satisfactory.

Eureka has been fruited now for six years, and has on the whole proved quite productive. The fruit is of a good size, fairly firm, ripens early, and gives a long season of fruiting.

Palmer has had its ups and downs, but on the average of six crops has made a good record. The fruit is of fair size and moderately firm.

Older has proved to be one of the hardiest varieties, and on the whole is one of the most productive. The fruit is large, glossy black, without bloom, not quite firm enough for a market berry, but one of the best for home use.

Gault has been under test for five years, and has made a very good record for productiveness. The fruit is of good size and fairly firm.

Hilborn is one of the old standard varieties, which is hardy and productive. The fruit is of medium size and only moderately firm.

Smith's Giant is a new variety, a seedling of the Gregg, raised by A. M. Smith, St. Catharines. It did not yield so well this year as in the two previous years, but the fruit is very large and quite firm. This variety is one of the latest to ripen its fruit, and will be valuable to lengthen the blackcap season.

Currants.

In our new currant plantation we have altogether forty-six varieties, and in all about seven hundred bushes. These were set out a year ago last fall; and although many of them began fruiting this year, we have thought it advisable not to report upon the comparative yields till next year, when all should be in bearing, and we could make better comparisons.

Most of the bushes have made excellent growth, and this plantation promises some interesting results.

In the older plantation are fifteen varieties, which have not been under close observation for six years. The two most productive varieties by far in this plantation have been Raby Castle and Prince Albert; but on both of them the berries are so much smaller than those on Fay's Prolific, Cherry, and Victoria, that they are not so desirable, either for home use or market.

All things considered, Fay's Prolific must still be conceded first place, both as a home and market currant. It is a good yielder, and the fruit is very large and handsome. Its worst fault is a sprawling habit of growth of bush, which necessitates careful pruning to keep it in shape.

Of the white currants, the White Grape is by far the most productive; in fact, this has always been the most productive currant in the whole collection, yielding about half as much again as the most productive red, and two or three times as much as the heaviest yielding black variety.

Among the black currants, the Black Naples has now been at the head of the list four times during the six years they have been under test; although the Champion makes a very close second.

In our new plantation there were twenty varieties which fruited, most of them for the first time this year. It is too early yet to make comparisons; but the most promising one so far is the Black Victoria. The young bushes of this variety bore a good crop of very large, handsome currants, of particularly good quality.

Gooseberries.

In the new plantation of gooseberries there are now about forty-five varieties under test, thirty-four of which fruited this year. A careful record was made of the yields, but it has been thought best not to publish these till another year, when all varieties should be in bearing.

In the older plantation, twelve varieties, six of them American and six English, have been under test for six years in succession, and the results have been very uniform from year to year. The following is the yield per bush for the average of six years' crops:

English Varieties.	Ounces.	American Varieties.	Ounces.
Autocrat	10.10	Pearl	62.42
Whitesmith	5.50	Downing	61.39
Crown Bob	5.47	Houghton	50.87
Industry	5.24	Champion	35.40
Triumph	2.40	Red Jacket	30.32
Dominion	2.27	Smith's Improved	14.60

Taking an average of the results given above, we may observe that, on the whole, the American varieties have been a little more than eight times as productive as the English varieties.

Until this year, the English varieties have always been more or less seriously affected with mildew, a disease from which the American varieties have always been exempt. This year there was little or no mildew on any of the varieties, and the crop was much better than usual. The cause of this, no doubt, was the unusually cool, moist season, which afforded conditions more like those of Great Britain, where these varieties do so well.

Pearl and Downing, which stand at the head of the list, are so nearly alike that it is hard to distinguish between the two. The berries are large, light green in color, and of good quality.

Red Jacket, although fifth on the list for productiveness, ranks next to the two just mentioned in value. It produces large, handsome berries, about one-half larger than those of Pearl and Downing, and for this reason is worth a little more in the market.

Tomatoes.

The past season, while particularly favorable for gooseberries, was unusually unfavorable for the ripening of tomatoes. The tomato requires a long season of warm weather to mature its full crop. During the cold, wet weather of last season, only the earliest ripening kinds matured fruit of any account, and even these did not give half of an average crop.

Forty-nine varieties of tomatoes have been included in our tomato experiments, which have been going on now for five years.

Atlantic Prize and Earliest of All, two of the earliest varieties, have for an average of four years been most productive, but this year and last they were surpassed by Dominion Day, a newer variety, introduced by Bruce of Hamilton. These varieties all began fruiting at the same time, and as far as appearances go, they are all very much alike.

Mayflower and Plentiful are two excellent later varieties which did well in former years, but last year they ripened only a very light crop.

IMPROVEMENTS ON THE CAMPUS.

With the addition of three large buildings on the campus this year, this department has had a lot of extra work in grading and levelling the grounds about them, and in the laying out of drives and walks to give easy access to them. We had not sufficient help to complete this work, as it should have been done this fall, and a lot of labor will be required next spring to put these parts of the grounds in good condition for sodding and seeding. The planting of trees and shrubs, which necessarily accompanies such improvements, will be proceeded with as soon as the ground can be got into condition for them. The trees and shrubs for this purpose have already been secured, and have been planted in the nursery rows, so that they will be on hand and in good condition for planting whenever the grounds are ready for them.

Respectfully submitted,

H. L. HUTT.

PART XII.

THE PROFESSOR OF BACTERIOLOGY.

To the President of the Ontario Agricultural College:

Sir,—I have the honor to submit herewith my report of the past year's work in the department of Bacteriology.

Lectures.

The usual courses of lectures to the students were given during the year. These comprise: (1) A course of 30 lectures on bacteriology in its relations with agriculture and dairying for second-year students. (2) A more advanced course on the same subject to fourth-year sudents. (3) To our fourth-year specialists in biology and horticulture, a special course of lectures on the bacterial diseases of plants, and those diseases produced by enzymes (e.g., mosaic disease, or Frenching of tobacco, Peach Yellows, etc.). (4) To the fourth year specialists in dairying, a rather extensive course of lectures and laboratory work on dairy bacteriology.

The special dairy class which is here for three months, monopolizes much of my time in the winter semester, because on account of our limited accommodation and the number of students, the work has to be repeated six times to get once over the class.

Last year I published a small text book, "Elementary Exercises in Dairy Bacteriology," which now forms the substance of the laboratory work in Dairy Bacteriology for the Dairy School students. These exercises are made as practical as possible, and treat of the following topics: The nature of milk; the effect of food, temperature, gaseous environment, physical agents, and chemicals on bacterial life; the bacterial contamination of milk; the fermentations of milk; pasteurization and sterilization; bacteria in butter-making; bacteria in cheese-making, etc. In view of the widespread complaints as to the keeping quality of milk, I have endeavored in these exercises to emphasize the danger of bacterial infection, and the reasons for cleanliness in all operations connected with the dairy business.

Meetings Attended.

During the year I attended a number of conventions and delivered addresses before the

1. Ontario Bee Keepers' Association. Adress: The use of Formalin for Controlling the Foul Brood of Bees.

2. The Western Dairymen's Association. Addresses: Bitter Milk and Cheese. Pasteurisation for Butter Makers.

3. The Ontario Normal School of Domestic Science. Addresses: The Preservation of Food Products; Milk as an Agency in the Conveyance of Disease.

4. The Dominion Master Bakers' Association. Address: The Abnormal Fermentations of Bread.

5. The Medical Health Officers' Association. Address: The Identity of Human and Avian Diphtheria.

Publications.

During the year the Ontario Department of Agriculture have issued several bulletins, prepared by myself, alone or in conjunction with other members of the College Staff. The titles of these are as follows :

Bull 117. Pasturization of Milk for Butter-Making, pp. 16 (wih Prof. Dean).

Bull. 118. Yeast and Its Household Use,—pp. 16.

Bull. 120. Bitter Milk and Cheese,—pp. 32.

Bull. 121. Ripening of Cheese in Cold Storage,—pp. 12. (With Profs. Dean and Harcourt.)

Besides the above, I contributed the "Story of the Yeast Plant" to the Nature Study Bulletin, recently published.

The Department has also in the press a bulletin by Dr. Streit and myself on "Roup, an Infectious Disease of Fowls."

Other publications during the year, appearing in various periodicals, are as follows :

La Duree de la Vie du bacille de la tuberculose, dans le fromage,—La Revue Generale du Lait, 1902.

Lait et Fromage Amers,—La Revue Generale du Lait, 1902.

Note on a new organism producing rot in cauliflower and allied plants, —Science, 1902.

My assistant, Dr. H. Streit, has also published: Die Vogeldiphtherie,—Zietschrift fur Hygiene und Infektions Krankheiten.

Routine Laboratory Work and Analysis.

During the year (11 months), we have manufactured and sent out 200 doses of tuberculin and 102 pure cultures, or starters, for cheese and butter making.

We have also made bacteriological analyses of the following substances, and have reported the results to those sending the material :

Water	3
Diseased hens and turkeys	23
Diseased organs, pus, etc.	26
Anthrax	8
Milk, off-flavored or suspected of causing disease	10
Urine	4
Off-flavored cheese	20
Off-flavored butter	2
Plants (bacterial disease)	5
Diseased swine	10
Total	101

As we are desirous of studying diseases of the udder (mammitis) we shall be glad to receive samples of milk from diseased udders, or portions of this organ, if the cows are slaughtered. In such cases, the results of our examination will be reported privately to those sending the material. We should also like farmers and veterinarians to make more use of the assistance we offered in the Report of 1901; and we again mention a few points on the subject of what to send and how to send it.

Assistance Offered to Veterinarians and Farmers.

In cases of disease,—send the organ or material carefully wrapped in an antiseptic wrapper, giving full particulars regarding it. It is best to send by express; and in summer it may be necessary to pack in ice.

In cases supposed to be, or suspected of being :

Anthrax,—send an ear, or some of the blood, spleen, or liver of the dead animal.

Symptomatic Anthrax, Black-leg, or Quarter Evil,—send the parts infected, as this disease is usually in the muscles.

Malignant Oedema (similar to black leg, but showing more fluid in the subcutaneous tissues, which, unlike the fluid found in cases of black leg, is almost colorless),—send the part affected.

Tetanus or Lockjaw,—on account of the difficulty of finding the bacillus of this disease, it is almost useless to send material, unless the point of inoculation is known, in which case, cut away and send the flesh around the point of inoculation.

Glanders (a disease which affects either the nasal passages or the skin, in the latter case called Farcy),—send some of the ulcers from the parts infected, or of the discharge from the nasal passages.

Hog Cholera and Swine Plague,—send any diseased portions of the animal.

Actinomycosis, or Lumpy Jaw,—send in a bottle a little of the matter found in the tumor mass.

Rabies, or Hydrophobia,—send the base of the brain or medulla oblongata of the animal suspected.

Tuberculosis and Pseudo-Tuberculosis,—send any tubercles or diseased glands.

Mammitis, or Inflammation of the Udder,—Send a sample of the milk in a clean bottle that has been boiled in water.

In cases of diseases affecting poultry, such as Chicken Cholera, Roup, Tuberculosis, or Blackhead,—send the whole bird.

Urgent Needs.

We need more room for practical work in bacteriology. The laboratory course for the dairy students has to be repeated six times in order to get round the class once; and when these students are in the laboratory, there is no room for our regular students or specialists. Our facilities for keeping animals—a small room in the basement—are not sufficient for our needs, and we are constantly receiving complaints from other people in the building about the smell from this room. We have obsolutely no accommodation for larger animals; and our experiments on swine diseases which are causing such loss in the Province, are at a standstill, because we have no isolation stable for experimental work. Such a stable is necessary for bacteriological investigation, and it would be very convenient for the Farm department to have a place to put diseased and suspected animals.

The establishment of the Macdonald Institute for Domestic Science and Manual Training will necessitate our giving a course of lectures and laboratory work on the preservation of foods, the bacteriology of milk, the use of yeast, the abnormal fermentations of bread and other food stuffs, etc., but with our present accommodation nothing in that line can be done. I would, therefore, urge that steps be taken to prepare for the eventualities mentioned, and others which are constantly arising in the department.

Research Work.

A considerable amount of research has been undertaken during

the year. In some cases, the work has been finished; in others, it is still in progress.

I may refer to this in a few short paragraphs.

A Bacterial Disease of Cauliflowers and Allied Vegetable. There has been considerable loss to market gardeners and farmers in this vicinity, and in other parts of the Province, from a rot of cauliflowers and white turnips. A large number of diseased plants were examined by us, and a bacillus isolated, with which we were able to produce the disease by inoculation into healthy turnips and cauliflowers.

A number of experiments were made with the organism, to find out how plants become infected, the susceptibility of different varieties, and the best methods of repression.

The following methods will serve to check the disease :

1. Use of a rotation, by which other crops are grown on infected soil for a number of years.

2. Control of insect pests, as these serve to spread the disease.

3. Early harvesting of the crop.

4. Storage in cellars with a temperature below that of the minimum temperature of growth of the germ (50 degrees F.)

5. The planting of resistent and immune varieties.

So far as I am aware, this is the second bacterial disease of plants met with in Canada.

A full report of these investigations will shortly be issued in bulletin form.

Roup. After four years' work, we have concluded our studies upon roup. We have succeeded in isolating several micro-organisms, with which we can produce Roup in healthy fowl. We have also definitely ascertained that Roup, or, as it is more scientifically termed, Fowl Diphtheria, is not identical with human diphtheria, but is a different disease, produced by a different bacillus or bacilli, and differing also in the lesions which it produces:

Besides working out the etiology (or inquiry into the physical causes) of Roup, we have indicated several remedies by which the disease may be controlled, if taken in time. The Department of Agriculture has issued our bulletin on the subject—a comparatively brief and popular discussion of the subject, with illustrations of the disease, methods of treatment, etc.

Abnormal Flavors in Cheese. Through the kindness of Mr. Woodward, of the Dominion Department of Agriculture, who is the official referee on export cheese at the port of Montreal, we have been able to secure a number of characteristic samples of off-flavored cheese, sent from different parts of Canada to Montreal, for exportation to the British market. It is Mr. Woodward's duty to state if the cheese is "finest" or not; and he very kindly sent us a number of samples of condemned cheese, that we might examine them, and, if possible, find out the cause, or causes, of the trouble, and suggest methods of prevention.

Samples of "off-flavored," "rancid," "stinking," and "fruity flavored" cheese, have been received; and from them we have isolated some interesting organisms, with which we have reproduced the flavors noticed in the samples they were taken from.

Our attention has been especially concentrated on the "fruity flavor." Seven or eight experimental cheese have been made during the season, with cultures of the different micro-organisms found in Mr. Woodward's samples, and we now have a collection of several yeasts, with which we have produced a characteristic fruity flavor.

According to Mr. Ruddick, of the Dominion Dairy Department, the term "fruity" is applied to a peculiar sweet flavor, of very pronounced character, which is frequently found in cheese. It has a strong resemblance to the odor of fermented fruit, certain kinds of wine, etc. It is found in cheese from different sections of the country, and during the different periods of the season, but does not appear to bear any relation to the other qualities of cheese, whether good or bad. Usually its appearance is intermittent, and only certain days' make, or particular batches, are affected.

The cause, as I have already intimated, is a yeast, or, perhaps, several species or varieties of yeast; and the well-known fact that yeasts are constantly found on the surface of fruits and leaves of trees, leads us to expect that these "fruity" yeasts come from this source. I have already experimentally demonstrated that the yeast which causes "bitter" milk and cheese has its habitat on the leaves of maples; and other writers have found other species on fruits and foliage.

Hence remedial measures should be directed to better care of the milk, and better places to keep the milk in. Uncovered cans should never be kept under trees, and the practice of returning the whey to the farm in the same set of cans as the milk was brought in, should be discontinued.

1. The Stables. The bacteria existing in the air of most of the stables are very undesirable, especially those whose habitat is in the manure, dried particles of which are wafted about in the building by the slightest currents of air, and fall into the milk pails during milking, and during straining when the cans are kept in the stable or close to the barnyard.

Stables should be kept clean (as free as possible from cobwebs and accumulations of dust), and be whitewashed twice a year, once in the fall and again in the spring, when the cows are put out to pasture. The whitewash should be made from fresh lime; and, after slaking, a wash of about the consistency of cream should be made, strained through a piece of sacking, and applied by means of a brush or ordinary spray-pump. In the latter case, two or more applications are necessary each time. A little molasses, size, or Portland cement, added to the whitewash increases its adhesiveness. In case disinfection is thought to be necessary, crude carbolic acid may be used in the proportion of a pint to every gallon of whitewash.

Whitewashing not only decreases the bacteriological infection; but it increases the amount of light in the stables, thus directly promoting the health of the stock.

2. The Care of Cans, Pails, Strainers, etc. Nothing is more difficult to clean properly than cans, pails, strainers, etc., with the facilities at hand on the average farm. No mater how hard the good housewife may scrub the can, she will rarely succeed in cleansing it so thoroughly that it will be free from bacterial life. A solution of soda is commonly used, and it is effective in removing grease and other forms of dirt; but it has very little germicidal value. Even a four per cent. solution is of little use as a germicide. The final scalding with hot water (one cannot say boiling water) is insufficient to kill the bacteria on the inner surface of the can, and in the cracks and crevices which are usually present. Steam, the best means of sterilizing cans, is not available on the farm. Hence the proper place for cleaning cans is at the factory, where all appliances are at hand for doing the work thoroughly and expeditiously. Let all cans be thoroughly washed and sterilized before they leave the factory; and then let the factory insist, and see to it, that those in charge of the work on the farms supplying milk, (1) wash and scrub thoroughly (and occasionally scour) all pails, strainers, dippers, and

other utensils used in handling the milk; (2) rinse all pails, strainers, dippers, etc., thoroughly with boiling water immediately before using; and (3) rinse the cans out thoroughly with boiling water a few minutes before putting the milk into them.

The practice of carrying ordinary, unpasteurized whey in milk cans from the factory to the farm cannot be too strongly condemned. So long as it is done, so long will there be trouble and serious loss from undesirable taints and flavors in milk; and the surprising thing is that good factories tolerate the practice. Let the whey be taken back in a can kept for the purpose; or, if that cannot be done, let all the whey be pasteurized at the factory by using the exhaust steam from the engine.

Utensils should be cleaned at the farm in the following manner : First, wash with water; then scrub well with a hot soda solution, using about two per cent. of soda (powdered concentrated ammonia may be used instead of soda; next empty out the soda washings, and scald with boiling water; lastly, empty the water out and allow the can to drain dry. Provide, if possible, some kind of cheap rack, to set the cans on, at an angle of about 15 degrees. On such a rack, the cans will dry out nicely, and will not be much exposed to infection from dust, falling leaves, etc.

Do not, on any account, leave the water in the can; and do not use cloths or brushes in the final rinsing with the boiling water.

Milking. The cows, before being turned out in the spring, should have their flanks, udders, and tails well clipped. If before milking, the udder of the cow is rubbed with a damp cloth, the germs which are present on the hairy coat of the animal are prevented from falling off into the milk pail, as bacteria cannot leave a moist surface. Milking should always be done with clean, dry hands. Immediately after milking, the milk should be strained through a brass wire sieve, with several thicknesses of cheese-cloth on it, or, better, a woollen cloth; but these cloths must be carefully cared for and rinsed in boiling water every day. If they are not so cared for, their use should be dispensed with, as neglected cloths are an undoubted source of infection.

A single germ.

Progeny of a single germ in 12 hours in milk cooled with cold water

Progeny of a single germ in 12 hours in milk allowed to cool naturally.

Fig. 1—Showing the effect of cooling milk on the growth of bacteria. The beneficial results of early chilling are manifest. (After Russell).

3. Aeration and Cooling. Aeration and cooling are both very desirable. I have already spoken of the effect of temperature on the growth of the bitter Torula; and the following figures show the rate of growth of a single germ :

A reference to Fig. 1 will show the beneficial effect of early cooling: and I am strongly of the opinion that, if the milk is cooled sufficiently, the trouble from the fruity Torula will be largely overcome.

The Copenhagen Milk Company require that the milk be cooled to 40 deg. F. at the farm, and that when delivered at the city establishment, it shall not be more than 50 degrees F. These figures are possibly too low for

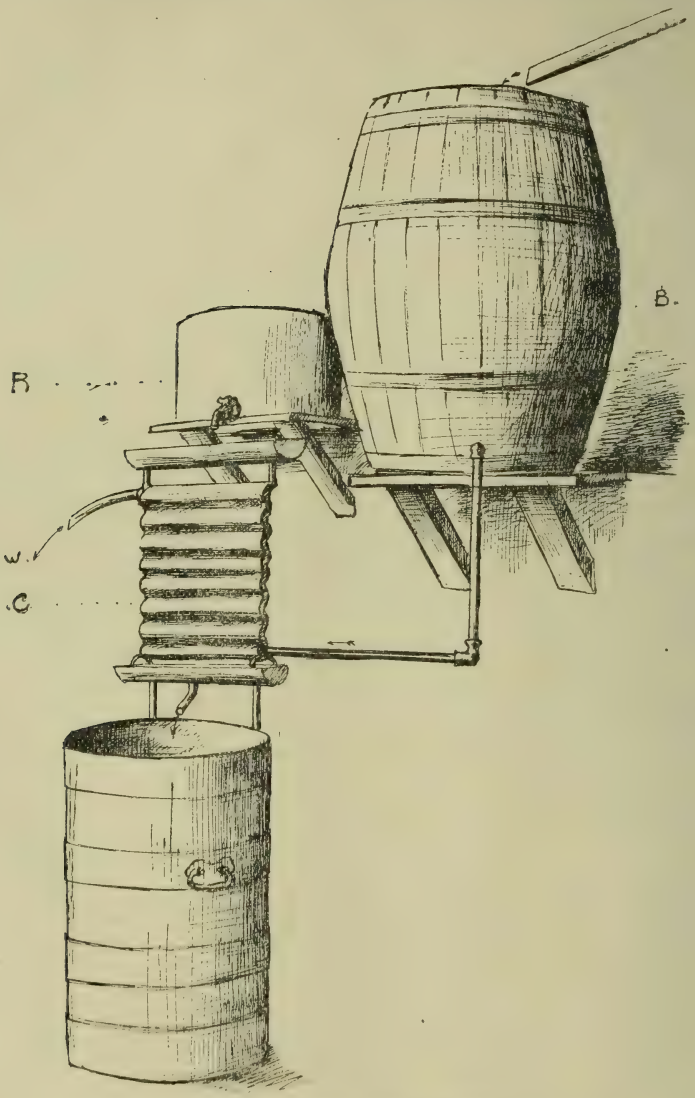


Fig. 2. Cooling and Aerating Apparatus.

B. Barrel filled with cold water from well.
R. Reservoir to hold contents of milk pails.
C. Cooler and aerator. The milk passes over the corrugations.
W. Waste water pipe from the cooler. The water enters below on the right side and passes out at W.

ordinary factory practice, but if the milk were cooled even to 60 deg. F. at the farm, or to a temperature, say, of two degrees above that of the water supply, it would be a great benefit.

Most of the best coolers aerate as well as cool, and those properly constructed should cool the milk to a temperature of two degrees above

that of the water used for cooling. Should the farmers be unwilling to incur the expense of buying coolers, an arrangement might be made, as at Copenhagen, Denmark, by which the factory would let coolers out on hire. These coolers, made of copper tinned over, are practically indestructible. With ordinary care, they will last for ten or more years, and when the tin wears off they can be replated.

Most farmers now have windmills for pumping water, and a connection could be made with a barrel or tank suitably placed; and, if necessary, ice could be used in the barrel.

4. Place for Milking. Throughout this bulletin, I have emphasized the fact that most patrons keep their milk cans, both before and after filling, in very unsuitable places, where there is constant danger of infection from harmful bacteria or from the absorption of objectionable odors.

The factory management should clearly and strongly forbid the following practices :

(1) The keeping of uncovered cans under trees.

(2) The keeping of uncovered cans near stables, piggeries, or barnyards.

(3) The keeping of cans for more than short periods on milkstands by the roadside.

Every farmer engaged in milk production should have a room in which to cool and aerate the milk immediately after milking, and to keep the filled cans until the time of putting them on the stand for the drawer to collect. This room need not be large or expensive, and it should be convenient to the stable or place of milking; but in no case should it be placed where there is a liability of infection from barnyard dust, or where the milk is in danger of absorbing stable, barnyard, or piggery odors. It should be sheltered from the prevailing wind. A lean to against a building often serves the purpose very well.

In this room, there should be space for the milk cooler and accessory apparatus, a spring weigh scale, and a requisite number of milk cans, a strainer, pails, etc.; and the milk, taken there immediately after milking, should be strained, and at once emptied into the tank above the cooler. In this way, the cooling and aeration would be finished a few minutes after the last pail of milk was drawn. Fig. 2 conveys some idea of what the interior of such a room should be like.

Slimy Milk. We are at present examining, studying, and comparing the bacteria which produce slimy or ropy milk. Some of these have been isolated from slimy milk, and others from stable air. During our investigation of "bitter" milk, we frequently encountered these organisms, and hence our study of this interesting group. The results will be published later.

ACKNOWLEDGEMENTS.

I desire to acknowledge the courtesy of the Horticultural department in allowing us the use of a portion of the greenhouses during our study of cauliflower rot; and of the Agricultural department for providing us with a few swine for experimental work on an infectious disease of hogs, very prevalent in this district.

I also desire to record my appreciation of the services of my assistant, Dr. Streit, who has labored unremittingly, early and late, on the work entrusted to him.

Anthrax.

During the summer of 1902, we had a large number of inquiries about anthrax, and we received a number of organs and samples of blood from animals suspected of having died with that disease. From the nature of the inquiries made, it is evident that many know little or nothing about this disease, which has resulted in serious losses on many farms.

The past season was a very favorable one for anthrax, for in wet years, when the ground water is high for a time and is followed by heat, many anthrax cases usually occur. The anthrax germ develops best on low, moist, swampy soils, which, after temporary inundation, dry out during hot weather. Hence we find that river flats are often infected; and some of them give rise to the disease every year. In one case which came under our notice, a farmer rented a low lying field in which cattle had died in former years. He was aware of this fact, but the knowledge did not deter him from pasturing a number of cattle in it. During a spell of hot weather an animal died; the carcass was only partially burnt, owing to lack of wood; some swine belonging to a neighbor, having got into the field, ate portions of the slightly charred or roasted flesh; and several of them died. Two kittens which had licked a few drops of blood oozing from the nostrils of the dead animal, died two days after. The farmer subsequently lost a few more of his cattle, and then changed his pasture.

This is a very good example of the risks that some men run from a lack of knowledge of this disease.

Another case which came under my observation a few years ago, involving the loss of stock and of a human life, occurred in the vicinity of a tannery. A workman handling some imported hides which had evidently come from an anthrax-infected district, contracted the disease and died. The drainage from the tannery ran into a small creek; and a number of cases of anthrax occurred on farms on both sides of the creek. To complete the chain of evidence as to the cause of the trouble, we isolated the anthrax germ from both the tannery effluent and creek. Other cases such as these might be cited, as tannery refuse dumped into streams has given rise to much anthrax on farms in the States of Delaware and Wisconsin.

The anthrax bacillus produces spores outside of the body; and on account of the formation of these very resistent forms, the germ is able to live or remain dormant in the soil for long periods of time. It has been known to live in soil for ten years.

The shallow burial of anthrax-infected animals, which have been cut open, in pasture fields or others places where animals graze, is always attended with a certain amount of risk, as the spores of the disease may be brought to the surface by earthworms, or by a rise in the ground water; and these spores again reproduce the disease if ingested by cattle or other animals. Even hay sold off such land may carry the disease. We once traced a case in this vicinity to hay which had been cut from an infected field.

The course of the disease is so sudden that farmers often think that their cattle have been poisoned. Hence in all cases of sudden death, an ear or a little blood from the animal should be sent to a bacteriological laboratory for examination.

The carcasses of animals that die from anthrax should be either deeply buried and well covered with quicklime, or completely burnt. If the animal has been opened and blood spilt on the surrounding ground, all portions of the ground touched by the blood must be thrown into the bottom of the hole dug for the carcass, or be well covered with wood and burnt.

SHORT NOTES ON A NEW CHICKEN DISEASE.

In the month of June, 1902, we received from Preston, Ont., a few chickens, sick with an unknown disease. The disease seemed to be infectious, and had caused great loss among the fowls of the farmer who brought us the affected birds.

Although our investigations are not quite satisfactory in all points, we have found certain peculiarities, which are set forth below:

Clinical Symptoms. The clinical symptoms are those of a progressive anaemia (deficiency of blood of red corpuscles). The diseased fowl separates from the others, loses its appetite and vigor, and soon becomes thinner and thinner. It is somnolent, and when awakened it takes a few staggering steps and soon lies down again. Water is freely taken till death comes. The visible mucous membrane and comb becomes gradually very pale. Towards death, which may occur after a fortnight, one, two, or even more months, a profuse diarrhoea sets in, which takes away the last strength of the fowl. The diarrhoeal discharge is very offensive—yellow-grey, and often greenish in color—and ends as a rule with paralysis of the muscles of the cloaca. The body temperature is never feverish. The temperature ran between 40.5 and 41.5 degrees C., a temperature which is usually found in healthy fowls.

The pathological-anatomic symptoms, which were studied in five birds, were always similar. The bodies were very thin. In one chicken all bones were soft (from rickets), and could be easily cut with a pair of scissors. The blood in the heart was coagulated. The spleen was always a little or much enlarged. In one case, it was full of the small nodules found in all the livers (see later). The liver was the most diseased organ. It was much enlarged and had a yellow color, similar to cases of fatty degeneration. The liver capsule was in one case covered with a grey layer of pus; in all other cases it was smooth, clear, or slightly cloudy. Under the capsule and throughout the whole liver parenchyma were numerous grey nodules, often prominent above the surface. The nodules were 1-3 mm. in diameter, and could easily be removed. They were round; often five or more had grown together into a mulberry-like body. Under the knife, these bodies were fairly hard. The open cut was structureless, grey, and the surrounding liver tissue showed no inflammation.

In one case, in which the fowl had suffered from severe diarrhoea, the intestinal walls, especially those of the ileum and rectum, showed many circumscribed haemorrhages into the mucous membrane and sub-mucous tissue. The intestines contained a yellow-red, offensive chyme.

Microscopical Examinations. The blood of both living and dead fowls was always peculiarly altered. I examined it many times, and at different hours in the day, and always found the same results, even after treatment with quinine had begun. The red blood cells were of varying shapes and sizes, about 5-15 u long and 4-8 u wide. Round forms were numerous, which are very seldom found in normal blood. The haemoglobin in the blood cells was often unequally distributed, some portions being much darker than others. The white bood cells were present in large numbers, about 10 to 20 and 30 red ones. Many of them were very large, 15-20 u in diameter, and contained in addition to the nuclei, many (counted once more than 40) shiny, slightly bent rods, 1-2 u long and 1-4 to 1-2 u wide, which looked like bacilli (see e and d, Fig. 1). These rods were strictly confined to the white blood cells, and were never found free in the blood. They could not be colored with any anilin stains (boiling carbol-fucshin, etc.) and slowly disappeared after addition of concentrated sulphuric acid.

Besides these two cell forms, there were small (2-4 u) round, elliptical bodies, about as numerous as white blood cells (see e in Fig. 1). They had the appearance of nuclei of red blood cells, could be stained easily, and showed a granular and reticulated structure.

The nodules in the liver and spleen, when crushed between two cover-glasses and examined in water, Lugol's solution, etc., consisted of small, elliptical or round cells, similar to those shown in Fig. 1 e.; some larger round cells, and debris of liver cells. The blood from the liver contained red and white blood cells and numerous protozoa. The protozoa were 7-12 u long, 2-5 u wide, and when examined in physiological salt solution, or in the blood alone, exhibited a continuous change of shape, but soon became motionless in Lugol's solution, potassium hydrate, or 2 per cent. acetic acid.

Fig. 1. Blood, stained with Methylene blue.

a. normal red blood cells.
b. small red blood cells.
c. white blood cell.
c1. enlarged white blood cells, containing bacilli-like foreign bodies.
d. crushed white blood cell, the enclosed bodies becoming free.
e. small nucleus-like round cells.

The movements of the protozoa were often amoeba-like, that is, the protozoa, approaching foreign bodies, sent out processes of their protoplasm, and retracted them after having past their bodies. The outlines of the protozoa were clear; many had a double membrane in places; others, a scale-like structure at one end (see Fig. 2). The whole body of the protozoon was slightly green and homogenous. Some forms showed a shade-like nuclear mass, slightly granular in structure when colored with methylene blue (1-4 hour), or with Romanowski or Ehrlich stains (see Fig. 1). Others showed, besides this central mass, a well-stained elliptical nucleus, like the bodies found in the blood shown in Fig. 1, e.

The motile bodies were more numerous in the fresh liver. When this organ was placed in sterile Petri-dishes at room temperature, they gradually decreased in numbers, and after 5-7 days had entirely disappeared. Instead, smaller round forms were observed, many of which were surrounded by a double membrane (see Fig. 2). These small, round bodies, though not so numerous as the motile forms, were still found after 5 and 6 weeks, when the whole liver had putrified. The same kind of protozoa were numerous in the haemorrhagic exudation in the mucous membrane of one chicken (see above), but could be observed in this location only for a few days.

In secretions from the liver and intestines, it was rather difficult to differentiate between red blood cells and protozoa, as both were much alike. The nodules in the liver were composed of smaller round cells, much like e in Fig. 1.

Many attempts to obtain cultures from blood, liver, spleen, etc., resulted in failure, as only a few B. coli-colonies occasionally appeared. Microscopic examination failed to demonstrate the presence of bacteria.

To determine whether the disease could be directly transferred, we made the following experiments:

Diseased fowls were kept with healthy ones for several weeks, without positive results.

Healthy fowls were fed with liver, spleen, blood, and intestines of diseased ones. The only result was that two chickens suffered on one occasion from diarrhoea for two days. Later, blood from diseased fowls was transferred to the vascular system of healthy hens, without positive results.

Therefore, there must exist other conditions which allow of the spread of this disease, as it is not transferable directly, and not infectious.

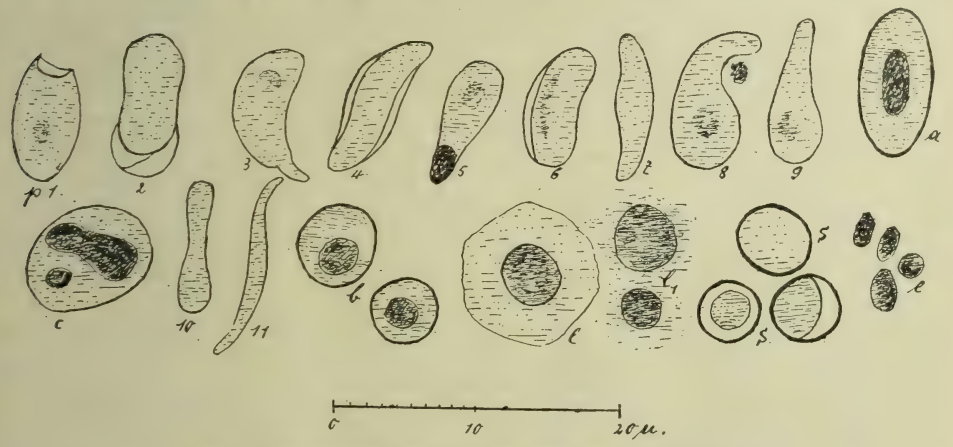


Fig. 2. Different bodies from fresh liver, stained with Methylene blue.

a. normal red blood cell.
b. small round red blood cells.
c. white blood cell.
e. small nucleus-like round cells, very numerous in the nodules.
l. liver cell.
ll. 2 nuclei of destroyed liver cells.
p1-p11. Protoza in different shapes.
s. spore-like bodies, after 4 days.

As quinine proved to be a specific for many protozoan diseases (malaria, etc.), we tried to cure some of the diseased fowls by giving them quinine in doses of from 2 to 6 grains twice a day. Neither the appearance of the blood nor the disease itself was modified thereby.

In conclusion, we may mention that T. Smith has described a protozoan entero-hepatitis in turkeys, which we have also observed here in Ontario; but this disease is different from ours, as in the cases we observed,

1. The enteritis was often not present at all, and when present, it never reached the severe stage of intestinal ulceration and diphtheria.

2. The macro and miscroscopical appearances of liver and spleen were different from those of Smith's disease.

3. The protozoa were very motile and changed into a more resistent spore-like form, when kept in unfavorable conditions.

H. STREIT.

THE IDENTITY OF HUMAN AND AVIAN DIPHTHERIA.

Diphtheria of the lower animals, especially of fowls and pigeons, has been the subject of numerous investigations; and when we examine the literature, we are immediately struck by the differences of opinion regarding the disease. On the one side, we have those who believe that the diphtheria of man and of birds are identical, and on the other side, those who believe that the one disease has no relation to the other.

If the two diseases are identical—that is, if both are caused by the same organism, the Klebs-Loeffler bacillus—we should have to demand the most rigorous treatment of diseased birds, and the disease would occupy a place of importance as high as that now accorded to bovine tuberculosis. But does our experience of the occurrence of fowl diphtheria and diphtheria in the human being lead us to the conclusion that there is a probability of there being any connection between the two diseases? Is not diphtheria a disease which is more prevalent in towns and closely-populated districts, where very few fowls are kept? Is not roup at certain seasons almost universally prevalent in some poultry yards in the country, where there may be hundreds of cases of the disease without a single case of diphtheria among those who look after the birds and treat them from day to day? Has it ever been observed that poultry-men are more frequently attacked with diphtheria than those who keep aloof from poultry yards? These and other questions suggest themselves to any one who critically examines the problem.

Let us, however, examine the work of various writers and investigators on the subject, which we may conveniently group under two heads:

1. Those who have investigated the disease as it occurs in fowls and pigeons, by the usual methods employed in working out infectious diseases.

2. Those who have made observations without experimental research, and who have not employed bacteriological methods to support or controvert their views, either for or against the identity of the disease as it appears in birds and man.

1. Experimental research:

Rivolta (1), Silvestrini (2), Friedberger (3) and Davaine (4), made a number of microscopical observations on the disease prior to the introduction of the bacteriological methods of Koch and Pasteur, and hence I shall not dwell upon their results, but pass on to the work of Loeffler (5), in 1884, on the diphtheria of pigeons and chickens.

From diphtheritic pseudo-membranes in the mouths of pigeons which died from an infectious form of diphtheria that prevails in Germany, Loeffler isolated a bacillus which when inoculated in pure culture into pigeons produced exactly the same symptoms as those which are met with in birds that acquire the disease naturally. This organism was quite different from the true diphtheria germ, and was not pathogenic for guinea pigs, rats, or dogs. Loeffler's discovery was subsequently confirmed by Cornil and Megnin (6).

Chicoli (7) and subsequently Krajeweski (8) found cocci in the false membranes of fowls, and Perroncito (9) saw coccidia in those of pigeons, chickens, and turkeys. In 1889, Pfeiffer (10) from fowls and pigeons attacked by diphtheria and contagious epithelioma observed corpuscles having ameboid movements which he considered were gregarines, and in other cases discovered flagellata which were difficult to distinguish from leucocytes.

The following year Babes and Puscariu (11) found Trichomonas showing the same characters as those described by Pfeiffer; but in diseased pigeons

these protozoa were associated with the bacillus discovered by Loeffler, and which alone was able to produce the disease. Thus the Trichomonas must be looked on as being normally present in the pharynx of pigeons. In 1894, Loir and Ducloux (12) studied in Tunis an epizootic of diphtheria which affected fowls, ducks, sparrows, pigeons, and turkeys. From all these cases they isolated a motile bacillus with rounded ends, which gave yellow colonies on gelatine and did not stain by Gram's method. As cases of diphtheritic angina were frequent among those who cared for the fowls, Loir and Ducloux made bacteriological examinations of such persons, and isolated in one case the same bacillus as was found in the diseased birds.

The inoculation of this bacillus into healthy fowls gave them the disease. The same year Piana and Galli-Valerio (13), whilst studying an epidemic of pigeon diphtheria, found large motile corpuscles, 4 μ in diameter, which these authors considered as protozoa.

In America, Veranus Moore (14) has isolated a bacillus from the false membranes of fowls, which resembled the organism causing swine plague. Moore inoculated a culture of this germ into a young hen, which died, but without showing false membranes. Aged fowls were quite refractory to inoculation.

Mazzanti (15), Piana (16), and others have confirmed the observations of Pfeiffer with regard to the presence of flagellata, either alone or accompanied by micro-organisms.

In 1898, as the result of experiments on diseased fowls with diphtheritic antitoxin, Stevenson (17), of London, Ont., recommended the use of this serum for the treatment of diseased birds, and stated that "roup," the popular name for fowl diphtheria, was "Caused by a specific germ which appears to me to be identical with the Klebs-Loeffler bacillus, and that roup and canker were the same disease, a disease identical with diphtheria in man."

In 1899, McFadyean and Hewlett (18) found bacteria resembling the Klebs-Loeffler bacillus in the throats of pigeons suffering from canker; but they demonstrated that the disease could not be produced in healthy birds by inoculation of pure cultures of this germ, and they showed that it had no toxic effect upon mice and guinea pigs, such as that produced by inoculation with *Bacillus diphtheriæ*. Therefore they concluded that it was not the same organism.

I (19) have also obtained a germ resembling the Klebs-Loeffler bacillus from the throats of pigeons which were perfectly healthy before examination and remained so afterwards.

The above are a few of the numerous works relating to the etiology of fowl diphtheria. Let us now examine the opinions of some of those writers who favor the identity of human and avian diphtheria.

Buniva supported the first hypothesis of the identity of the two diseases. In 1879, Nicati (20) reported that cases of human diphtheria, especially of the conjunctiva, increased after epizootics of avian diphtheria. Menzies (21) announced that at Posillipo cases of diphtheria were noticed among children who drank water which flowed over a terrace occupied by pigeons and fowls. Gerhardt (22) published the report of an outbreak of diphtheria amongst two-thirds of the employees of a poultry establishment at Nesselhausen, where thousands of fowls had succumbed to diphtheria. One of the employees pecked by a diphtheritic rooster in the hand and foot subsequently showed false membranes in these locations. No cases of diphtheria were present in the environs of Nesselhausen at the time. Roth

(23) reported that fowls which had swallowed the false membranes of diphtheritic children were affected by this disease.

Wheeler (24) observed diphtheria in a family which had eaten doves affected with diphtheria. Turner (25) stated that infant croup had been preceded by fowl diphtheria.

According to Paulinis (26), the Greek Isle of Skiatos, in which diphtheria had never previously been known, was infected after the introduction of diphtheritic turkeys. Boing (27), Hingworth (28), and Bilhaut (29), cited cases of the direct transmission of chicken diphtheria to man. In 1884, Chicoli (7) produced diphtheria in fowls by the inoculation of false membranes from man, and observed at the same time diphtheria among children who frequented places used by fowls affected by the disease. Emmerich (30), also established in his experiments that pigeon diphtheria could be transmitted to man, and *vice versa*. Bermont (31) observed at Bonvilers an epidemic of diphtheria among children affected with scarlatina, who lived in places occupied by diphtheritic chickens. Longuet (32) saw the disease in a soldier who attended chickens which were infected. Tissier and Longuet (33), thought that in 40 per cent. of the cases infected manure was the cause of the spread of the disease. This idea was supported by Chauveau (34), who considered the two diseases identical. Barbier (35) frequently saw diphtheria among fowls which lived beside insulated buildings for diphtheria patients, and stated the case of a woman, 67 years of age, who was attacked by diphtheria after having disinfected a poultry building infected with the disease.

Debrie (36) reported an interesting case. Some soldiers affected with diphtheria were admitted to the hospital at Sebdou. Immediately, the fowls, which were looked after by a hospital attendant, presented symptoms of diphtheria, and the owner and a soldier who cared for them were also infected. Cole (37) and Schrevens (38) also reported cases of the transmission of chicken diphtheria to children.

Such are the incidents given and statements made by those who believe in the identity of the two diseases; and against them there are almost as many made by the dualists, or those who believe the two diseases entirely distinct.

Thus, a pupil of Trasbot's (39), swallowed the false membrane of several hens without contracting diphtheria. Megnin (40) never observed diphtheria among those who took care of diphtheritic birds. Rivolta (41), discussing the observations of Gerhardt, said that the false membranes of fowls were not diphtheritic, but crouposus, and that if the epidemic observed among the employees at Nesselhausen had been true diphtheria, it would not have remained localized, but would have spread to the environs. It was possible that the infection was transmitted from the fowls to man, but it was not diphtheria, but a light attack of croup.

Sante Sirena (42), studying the same epidemic reported upon by Chicoli, declared that he never saw a case of the transmission of the disease from birds to man, and that never had the cases of human diphtheria in Palermo been so rare as at the time of this epidemic!

Loeffler (5), the discoverer of the human diphtheria germ, was never able to produce diphtheria in fowls by the inoculation of the true bacillus; and Colin (43) obtained the same results. Nocard (44) denied the identity of the two diseases; and St. Yves Menard (45) considered the false membranes of fowls quite different from those of man, and had never seen cases of the transmission of the disease in the "Jardined acclimatation of Paris." Strauss

had never observed cases of diphtheria among those who took care of diphtheritic pigeons. Gratia and Lienaux (46) and one favorable result from the administration of diphtheria anti-toxin to a diphtheritic chicken; but in all other cases the results were negative. These authors concluded that the inefficacy of this remedy for poultry was an argument against the identity of the avian and human forms of diphtheria.

It is impossible to bring into agreement all the data furnished by the above experimenters, unless we admit that the diphtheria of the birds in either produced by several different species of bacteria and perhaps coccidia, or that under the name of diphtheria there has been, as Galli-Valerio (47) remarks, "a lamentable confusion of different affections." We know that infectious pseudo-membranous inflammation of mucous membranes may be caused by the *Streptococcus pyogenes*, *Staphylococcus pyogenes*, and other bacteria; and many of the disorders caused by these organisms resemble very closely the local and general phenomena of diphtheria caused by the Klebs-Loeffler bacillus, and if such is the case in the human subject, it is more than probable it is also true of birds.

Seeing, therefore, that the research upon the etiology (physical cause or causes) of the diphtheritic affections of birds was so incomplete and so controversial, we have given this subject considerable attention, the work extending over a period of the last four years, and involving observations and inoculations of some 300 fowls.

The publicity given to Stevenson's paper in the Agricultural press led us first to examine the effect of human diphtheria anti-toxin on birds suffering from diphtheria and having well characterised pseudo-membranes. The anti-toxin was injected subcutaneously, and after the operation the birds were observed every day for a week, and then at longer intervals. Many were kept under observation for several months.

A series of thirty birds was inoculated with fresh serum, obtained from well recognized sources (Parke, Davis, and Mulford). The dose varied from 250-550 units, given either at one time or at intervals. Of the thirty birds so treated, but two showed signs of improvement, following immediately after the injection; but, three days after they were again badly diseased. The remaining 28 either showed no improvement, or even became worse after the treatment. In ten cases the disease persisted for three months, when the birds were killed and examined.

A series of eight birds was also treated with fresh horse serum, in doses from 2 to 5 c.c. Two hens treated with the larger dose died twenty-four hours after injection, a proof of the toxic nature of some horse sera, a fact which Cobbett has already pointed out. Two other birds showed some signs of improvement after treatment with smaller doses; and our Poultry Manager, reported to me after trying the fresh horse serum on a number of diseased birds, that in some cases he had seen partial cures, but it was not specific, and did not seem of much use.

The results of these experiments, therefore, show that :

1. Diphtheria anti-toxin inoculated into birds suffering from fowl diphtheria, and presenting pseudo-membranes, produced no practical or permanent results.

2. Were the germs of human and avian diphtheria the same, this anti-toxin certainly must have influenced the fowl diphtheria, since it is the best remedy known for human diphtheria.

3. Ordinary horse serum showed better results than anti-diphtheritic serum, but it could not be regarded as a specific.

The third series of experiments was made on five healthy fowls, which

were injected with human diphtheria bacilli, which were obtained from two different cases and isolated on Loeffler's serum.

Fowl 1. Inoculated by scratching throat and rubbing in a twenty-four hour old culture of the Klebs-Loeffler bacillus. No membrane formed. Bird remained healthy.

Fowl 2. Same procedure, but bacillus from another source. No membrane formed. Bird remained healthy.

Fowl 3. Inoculated subcutaneously with the half of a serum culture of the K.-L. bacillus. No results.

Fowl 4. Same procedure, but bacillus from another source. No ill effects.

Fowl 5. Inoculated in sub-mucosa, with about half a c.c. of a K.-L. culture. No membrane formed. Bird remained healthy.

Two guinea pigs inoculated with the same culture died within thirty-six hours with typical symptoms of diphtheria.

The results of these experiments, therefore, show that the Klebs Loeffler bacillus is not pathogenic for hens.

We may also mention, in this connection, that we have repeatedly tried to infect rabbits and guinea pigs by injecting false membranes taken from diseased hens, but never with any success. We have also kept rabbits and guinea pigs confined in cages with disease hens; but these animals have never taken the disease. Stevenson stated that in his experiments when rabbits were fed from the same vessel as a roupy bird, they became infected with the disease and died as the result. But experiments conducted here have entirely failed to corroborate this statement. Not only did rabbits live for weeks in coops with roupy birds without becoming affected, but a doe brought up a litter in a coop in which were kept the worst procurable cases of fowl diphtheria; and these rabbits, though drinking from a vessel used by diseased birds, which was uncleaned for weeks, and eating hay and roots which were in constant contact with the birds, never showed any symptoms of ill health. If the disease in the fowls had been caused by the Klebs-Loeffler bacillus, it would certainly have been pathogenic for both the rabbits and guinea pigs, as we know these animals are used for standardising the diphtheria anti-toxin.

We have made cultures from over two hundred fowls, which died from diphtheria or were killed in certain stages of the disease, but we have not met with the Klebs-Loeffler bacillus in any of them, and consequently we cannot believe in the identity of the human and avian diseases.

We also find that the structure of the diphtheritic membrane of men and fowls is different. In the former, it consists of necrosed epithelial cells, and inflammation of the connective tissue beneath, with an abundant fibrinous exudation. If the membrane is formed in the trachea instead of the pharynx, the epithelial cells are shed, and the membrane consists almost entirely of fibrin, with leucocytes, the former arranged in laminae, but varying in density. The diphtheria bacilli are most frequently found lying in clumps in the spaces between the fibrin, and are usually most numerous in the superficial part of the membrane. The bacteria stain very well by Gram's method.

The membrane in fowls, however, consists almost entirely of pus cells, some granular masses, debris of epithelial cells (especially the swollen nuclei of these), and bacteria; and the micro-organisms which stain by Gram's method are seldom found in it.

This year we have succeeded in isolating certain bacteria from diseased birds, and producing the typical disease in healthy birds by the injection of these bacteria.

Our final results and successes were obtained by using pigeons in order to increase the virulence of the casual organisms. Chronic diseases, of which we have an excellent example in fowl diphtheria, are notoriously hard to reproduce by the inoculation of healthy animals, because in most cases of sickness there must be not only the casual organism, but a lowering of the vital forces; and, to get over the difficulty, we used pigeons, which are easily infected, to increase the virulence of the casual organisms, and thereby assist in the infection of hens. In this way we produced roup in hens at pleasure by inoculation with the roup bacillus taken from roupy pigeons.

The roup bacillus tends to penetrate the deeper layers of the mucous membranes or submucous tissues. Hence, cultures made from swabs taken from false membranes very rarely contain the roup bacillus, because the bacilli are retained in the depths of the tissue.

The roup bacillus (which we have named *Bacillus cacosmus*) is especially difficult to isolate in cases in which the bird has had the disease for a length of time, as the tumors and false membranes contain very many other kinds of bacteria in large numbers. In our experiments, even when roup was produced in healthy fowls by the inoculation of pure cultures of the "roup bacillus," the mucous discharge from the very beginning contained many different kinds of bacteria.

The roup germs seem capable of remaining in a sort of dormant condition in the depths of the tissues for a very long time,—so long that the fowls sometimes appear convalescent; but suddenly, when the constitution is weakened by cold or other causes the roup germs become active, and the diphtheria symptoms re-appear.

We have found that roup with all its varying symptoms, can be produced also by the inoculation of healthy hens with the well known *Bacillus pyocyaneus* or green pus germ, which we have frequently isolated from roupy birds. Hence, it would seem that roup is simply a complex suppurative process, but different from ordinary forms of suppuration, the pus in fowls appears in the form of a half or entirely solid, cheese-like, yellowish white mass, without any tendency to become soft or liquid, or to perforate the surrounding skin.

This may be proved by the injection of sterile turpentine oil into the eyelids, which gives rise to inflammation, and the formation of a solid, cheese-like matter in the depths of the tumour.

Therefore, the cheesy masses must be regarded as pus.

The evidence adduced in the preceding paragraphs of this paper, the isolation of the casual organisms (the Roup Bacillus and the *Bacillus pyocyaneus*), and the production of typical fowl diphtheria by the inoculation of cultures of both of these bacteria into healthy birds, have, we think, shown the unsoundness of the theory of those who believe in the identity of human and avian diphtheria.

We are unable to state the possible danger of the Roup Bacillus to man; but we know that the *Bacillus pyocyaneus* produces abscesses, and occasionally gives rise to an epidemic of blood poisoning, as Williams and Cameron (48), have shown; but neither of these bacteria has the same pathogenic power as human diphtheria.

LITERATURE.*

1. Giornale di anatomia, fisiol, e patol., 1873, p. 42.
2. Idem.

*NOTE. I desire to acknowledge my indebtedness for literature and references to Prof. Dr. Bruno Galli-Valerio of Lausanne. F. C. HARRISON.

3. Deutsche Zeitschr. f. Tiermed, 1879, p. 161.
4. Dict. Encylop, 1875.
5. Mitteil a. d. k. Gesundheitsamte 2, 1884, p. 482.
6. Revue d'hygiene, 1884, p. 850.
7. Sicilia agricola, 1884.
8. Deutsche Zeitschrift. Tiermed. Bd. 13, 1887, p. 311.
9. Il Medico veterinario, 1886, p. 249
10. Zeitschrift. f. Hygiene. Bd. 5, 1889, p. 363.
11. Zeitschrift f. Hygiene. Bd. 8, 1890, p. 376.
12. Annales de l'Institut Pasteur, 1894, p. 599.
13. Moderno Zooiatro, 1894.
14. U. S. Dept. of Agric. Bureau of Animal Industry. Bull. 8, 1895.
15. Giorn. R. Soc. e Acc. vet., 1896, No. 10. Osservazioni clinico-sperimentali sulla pseudo difterite da cercomonadi. Parma, 1896.
16. Moderno Zooiatro, 1894.
17. Stevenson, Journ. of Comp. Med., July, 1898; Farmers' Advocate, 1898, p. 213.
18. McFadyean and Hewlett. British Med. Jour., 1899, 2, p. 1,357.
19. Report Ont. Agr. College, 1901.
20. Revue d'hygiene, 1879, p. 237.
21 Menzies, These de Paris, 1881.
22. Allg. Wiener Med. Zeit., 1883.
23. Adam's Wochenschrift, 1883, 27 J., p. 173.
24. American Practitioner, 1887.
25. British Medical Journal, 1887, vol. 2, p. 416.
26. Bull. medicale, 1888, p. 90.
27. Deutsche med. Wochenschrift, 1886, p. 552.
28. British Medical Journal, 1888, Vol. 2, p. 166.
29. Journal de Medicine de Paris, 1890, p. 441.
30. Revue d'hygiene, 1884, p. 850.
31. Poincarre Rev. med. de l'est, 1890, p. 633.
32. Stat. med. de l'armee francaise, 1886, p. 45.
33. Rev. d'hygiene, 1887, p. 915.
34. Ditto, 1887, p. 917.
35. Gaz. med. de Paris, 1889, p. 37.
36. Arch. de med. et pharm. milit, 1892, No. 3, p. 204.
37. Arch. of Pediatrics, Vol. 11, 1894, No. 3, p. 204.
38. Bull. Acad. med. Belgique, 1896, T. 8, p. 380.
39. Annales de Medecine Veterinaire, 1879, p. 465.
40. Rev. d'hyg., 1879, p. 585.
41. Giornale di anat. e fisiol, 1884, p. 3.
42. Giorn. internaz. delle sc. med., 1884, Vol 8, p. 271.
43. Acad. des Sciences, January 15, 1885.
44. Rec. de med. vet., 1889, p. 5.
45. Rev. d'hyg., 1890, p. 410.
46. Annales de med. vet., 1896, p. 186.
47. Central. f. Bakt. I., 22, 1897, p. 506.
48. Journal of Pathology and Bacteriology. 1896, p. 344.

I have the honor to be,

Your obedient servant,

F. C. HARRISON.

PART XIII.

THE EXPERIMENTALIST.

To the President of the Ontario Agricultural College:

Sir,—I have the honor of submitting herewith my report of the work done in the Experimental department during the year 1902.

Field Agriculture, or Agronomy.

My work in connection with Field Agriculture, or Agronomy, for the past year may be summarized in a general way under the following heads:

1. Conducting experiments on about 2,000 plots of sufficient size, to enable us to ascertain the yields of the various crops under investigation. The results of this work are presented in this report.

2. Carrying on scientific work, especially in the hybridization of farm plants, along the line of the discoveries of Mendel and the investigations of De Vries, Correns, Bateson, and others.

3. Directing co-operative experiments on 3,135 farms throughout the Province. The co-operative experimental work in Ontario is exerting an influence which is wholesome in its character and far reaching in its results. For the reports of the co-operative work, the reader is referred to the Annual Report of the Ontario Agricultural and Experimental Union.

4. Delivering lectures to College students and agricultural conventions —about 100 in number. Within the past year, the writer has delivered lectures to about 100 students in the regular College course, 60 students in the dairy course, and 210 students in the short course in stock and grain judging. The other lectures which have been delivered since last year are about as follows: 31 at meetings of Farmers' Institutes; 30 in the experimental grounds to 20,000 to 25,000 excursionists who visited the College in the month of June; 3 at Seed Fairs; 3 at the "Model Fair" at Whitby; 1 at the Annual Meeting of the Canadian Fairs' Association, Toronto; 2 at the Annual Meeting of the Ontario Agricultural and Experimental Union; 1 at the Provincial Winter Fair, Guelph; 1 at the First National School of Agriculture for the United States, State University, Columbus, Ohio; and 4 in different school sections in connection with the proposed establishment of the first Consolidated Rural School in Ontario for the teaching of manual training, domestic science, nature study, and agriculture, along with the ordinary branches of elementary education.

5. Writing Report, Bulletins, and Agricultural Articles. (1) Report of the Experimental Department at the College; (2) Report of the co-operative experiments in agriculture in connection with the Ontario Agricultural and Experimental Union; (3) Bulletin on "Peas and the Pea Weevil"; (4) Part of a bulletin on "Nature Study or Stories in Agriculture"; (5) Miscellaneous articles for agricultural journals, newspapers, etc.

6. Carrying on a heavy agricultural correspondence. The amount of correspondence with Ontario farmers is increasing from year to year. For several weeks in the spring, and again in the fall, the number of letters and cards received daily average more than one hundred. Some of these enquiries take much thought and care in answering.

7. Judging at agricultural exhibitions. In 1902, the writer acted as judge on farm crops at the following Agricultural Fairs: The Industrial Exhibition, Toronto; the "Model Fair," Whitby; the Agricultural Fair, Berlin; the Agricultural Fair, Wellesley; the Broadview Boys' Institute Fair, Toronto; the Spring Seed Fair, Guelph; the Fall Seed Fair, Guelph; and the Spring Seed Fair, Fergus. The exhibits of farm crops at the "Model Fair" at Whitby were much better, from an educational point of view, than those at most of the other fairs, for the following reasons: (1) The varieties were all correctly named; (2) the grain exhibits were represented by small sheaves, showing the length and quality of the straw, and the nature of the head, as well as by the threshed grain of each variety; and (3) some of the classes of roots, corn, millet, grasses, clovers, etc., were shown in the experimental plots on the grounds outside, as well as in the exhibits inside of the buildings.

Experiments at the College.

The practical work in the Experimental Department consists in planning the various experiments; laying out, seeding, and looking after the field plots; harvesting, threshing, weighing, and testing the grain; taking up, weighing, counting, testing, and storing the potatoes and roots; cutting, weighing, and harvesting the grass, corn, and fodder crops, etc.; and also in picking by hand the samples of grain grown on the plots, some to be sown on the plots the following year, and some to be distributed for co-operative experimental work throughout Ontario. But few people realize what a large amount of very careful thought is required in planning, supervising, and examining these crops, and in studying, comparing, and summarizing the results for presentation in reports, bulletins, newspaper articles, and lectures.

Experimental Grounds. About fifty acres of land, divided into more than 2,000 plots, is used for agricultural field experiments, conducted with varieties of grain, root, tuber, grass, clover, fodder, silage, and miscellaneous crops; with artificial, green, and farmyard manure; with methods of cultivation, selection of seed, dates of seeding, etc.—all with the greatest care, and for several years in succession—in order to secure strictly accurate and reliable results. These experiments deal with the crops grown on over nine-tenths of the cultivated land in Ontario; that is, fully 10,000,000 acres.

Experimental Plots. The experimental grounds have a gentle slope toward the southwest, and the soil is what might be termed an average clay loam. Nearly one-quarter of the land is manured each year with twenty tons (about twelve loads) of farm-yard manure per acre. It will thus be seen that the most of the land receives farm-yard manure once every four years. No commercial fertilizers are used, except in distinct fertilizer experiments, which occupy from two to three acres each year, and on which tests are made to ascertain the comparative value of different fertilizers with different crops. The plots vary in size according to the requirements of the different experiments, and the yields per acre are determined from the actual yields of the plots in every instance.

Weather Conditions in 1902. Regarding the weather conditions of the past summer, we should carefully note a few points when considering the results of experiments with field crops. The month of March was exceptionally warm, and the month of June was very much cooler than usual. Owing to the unusually warm weather in the very early spring, we were enabled

to sow our varieties of spring wheat on the 27th of March, which was fully two weeks earlier than the earliest seeding that has taken place on the College farm within the past fifteen years. The mean temperature in the month of June was about five degrees lower than the mean temperature in June for several years past. The total rainfall at the College, according to the determinations made by the department of Physics, was 6.4 inches, while that for July, 1901, was 4.1 inches, and for July, 1900, 3.1 inches. In fact, the rainfall throughout the whole summer was much larger than usual.

Results of Experiments.

All our field experiments are conducted for at least five years before any of them are dropped. For the results of many of the tests which were carried on for five years previous to 1902, the reader is referred to former reports. The results of some of the experiments which have as yet been conducted for only one or two years are held back until the tests can be carried through at least another summer. As different seasons vary so much in temperature, amount of rainfall, etc., the average results of experiments continued for several years are of much greater value than those secured from only one year's work. We submit the results with much confidence in their reliability, and in their real, practical value. The writer has had good reason to believe that the work of the Experimental department is being appreciated by the farmers of the Province, and that the results are being studied more and more each succeeding year. I shall limit my remarks on each separate experiment, the results of which are here presented, to a few of the points which seem to be of the greatest value to the agriculture of Ontario.

Selection of Seed Grain.

The average market annual value of the wheat, oats, barley, and peas grown in Ontario for the past twenty years is, according to the Reports of the Bureau of Industries, $57,709,840. Any improvements, therefore, which can be made in the choice of varieties, in the selection of seed, in the methods of cultivation, etc., which will increase the value of these crops 10 per cent. per annum will thereby increase the total value of these crops in Ontario by nearly $8,000,000 in a single average year. Believing that the majority of the farmers of Ontario were not obtaining so good results as they might if they sowed the very best quality of seed, a systematic line of experiments was started nine years ago, to ascertain the comparative results upon the immediate crop from a simple but careful selection of seed. The results obtained show the great importance of making a proper selection of seed if we hope to get the best returns. It should be clearly understood that the results which are here presented represent in every case only one season's influence. The experiments were repeated from six to nine years by starting with fresh seed in the spring of each year. The average results, therefore, of these various years, covering different conditions of moisture, temperature, and soil, are worthy of careful consideration. They show about what may be expected from a simple selection of seed upon the immediate crop, and give room for serious thought regarding the carelessness of some people in the preparation of seed for sowing on their farms from year to year. We are greatly pleased to know that many farmers are now taking much greater care as to the quality of

the seed which they sow than they did in previous years, and we hope that many others may also be encouraged to greater carefulness in the selection of the seed which they sow in their fields.

In the experiments conducted in the selection of seed, it should be clearly understood that the different selections were made with great care, and were clearly defined in every case. For the large, plump seed, none but well-developed seeds were selected; for the small plump seed, the sample of grain selected was of a uniform character; and for the shrunken sample, none but shrunken grains were used—the last selection being made regardless of the size of the kernels. An equal number of grains of each selection was used, the object being to ascertain the comparative productiveness of the seeds of the different selections.

Winter Wheat. The experiment in making different selections of winter wheat has been conducted for six years in succession. The average results for the six years are as follows: Large plump seed, 46.9 bushels of grain per acre, 2.6 tons of straw per acre, and 59.4 pounds of grain per measured bushel; small plump seed, 40.4 bushels of grain per acre, 2.2 tons of straw per acre, and 59.2 pounds of grain per measured bushel; shrunken seed, 39.1 bushels of grain per acre, 2.1 tons of straw per acre, and 59.0 pounds of grain per measured bushel; and split seed, 9.3 bushels of grain per acre, 3-5 of a ton of straw per acre, and 54.2 pounds of grain per measured bushel. From the results here presented, it will be seen that the large plump seed gave decidedly the best results; that there was not very much difference between the small plump seed and the shrunkn seed; and that the split and broken seed gave exceedingly poor returns. When the grain of wheat is broken by the separator, in many cases the germ is either destroyed entirely or the kernel is so injured that it is not apt to produce a strong, vigorous growth.

Spring Wheat. The experiment in testing different selections of spring wheat has been conducted for a period of eight years. In averaging the results for the eight years, we have obtained the following summary: Large plump seed, 21.7 bushels of grain per acre, 1.4 tons of straw per acre, and 59.1 pounds of grain per measured bushel; small plump seed, 18.0 bushels of grain per acre, 1.3 tons of straw per acre, and 58.3 pounds of grain per measured bushel; and shrunken seed, 16.7 bushels of grain per acre, 1.2 tons of straw per acre, and 56.9 pounds of grain per measured bushel. It will be seen that the small plump seed gave poorer results than the large plump seed, and that the shrunken seed gave poorer results than the small plump seed in every particular.

Barley. Four selections of barley have been tested for six years. In averaging the results obtained from these experiments for the whole period during which they have been carried on, we have obtained the following averages: Large plump seed, 53.8 bushels of grain per acre; 1.5 tons of straw per acre, and 49.5 pounds of grain per measured bushel; small plump seed, 50.4 bushels of grain per acre, 1.5 tons of straw per acre, and 48.8 pounds per measured bushel; shrunken seed, 46.0 bushels of grain per acre, 1,4 tons of straw per acre, and 49.1 pounds of grain per measured bushel; and broken seed, 43.2 bushels of grain per acre, 1.3 tons of straw per acre, and 48.6 pounds of grain per measured bushel. It will be observed that the broken barley gave much better results than the split wheat. Those who have observed the result of the work of the separator in threshing will notice that the barley is usually broken crosswise, and that the wheat is usually split through the crease which extends from one end to the other. Therefore, the germ of the wheat is much more apt to be destroyed by the

separator than the germ of barley. The principal reason that the broken seed of barley gives a less yield than any of the other selections is not so much the result of the injury done to the germ, as in the removal of about one-half of the kernel, which is then unable to supply the young plant with food sufficient to give it a good start.

Oats. For seven years an experiment has been conducted in selecting large seed, medium-sized seed, and small seed of oats. The average results obtained from these selections during the entire period of the experiment are as follows: Large seed, 62 bushels of grain per acre, 1.9 tons of straw per acre, and 33.2 pounds of grain per measured bushel; medium sized seed, 54.1 bushels of grain per acre, 1.8 tons of straw per acre, and 32.2 pounds of grain per measured bushel; and small seed, 46.6 bushels of grain per acre, 1.8 tons of straw per acre, and 31.8 pounds of grain per measured bushel. The results indicate that as the seed oat decreases in size, the plant becomes smaller and the yield of grain considerably less.

Peas. A test has been made for six years in comparing large peas with small peas of the same variety. The average results for each selection are as follows: Large seed, 28.1 bushels of grain per acre, 1.3 tons of straw per acre, and 56.3 pounds of grain per measured bushel; and small seed, 23.0 bushels of grain per acre, 1.1 tons of straw per acre, and 56.3 pounds of grain per measured bushel.

Another experiment has been conducted for nine years in succession in which sound peas have been compared with peas that were split in the process of threshing. The average results for the nine years' comparison gives us the following figures: Sound seed, 29.2 bushels of grain per acre, 1.4 tons of straw per acre, and 58.1 pounds of grain per measured bushel; and split peas, 10.2 bushels of grain per acre, 3-5 of a ton of straw per acre, and 57.9 pounds of grain per measured bushel. It should be remembered that the split and broken grain has an advantage over the other grain in the case of peas and wheat, owing to the fact that each plant which grows has more room for development than in the case of the other selections, where there is a more complete germination.

These results are certainly very suggestive throughout, and indicate very clearly the great importance of taking special pains in the selection of the seed sown.

Grains Grown in Mixtures for the Grain and Straw.

For six years in succession, a comprehensive experiment was conducted in growing oats, spring wheat, barley, and peas separately and in various combinations for the production of grain and straw. It was found that a mixture of oats and barley gave the highest yield of grain per acre; and having ascertained that a mixture of oats and barley was well adapted to a large production of grain, it became of importance to know the best proportions of these grains to use in the mixture to give the most satisfactory returns.

Barley and Oats. It was decided in the spring of 1900 to conduct an experiment in sowing nine different proportions of oats and barley in order to determine which mixture and which quality of seed would give the best results in the production of grain and straw. The following gives the amounts of oats and barley per acre used for seed in the different mixtures: (1) Oats, 1-2 bu. and Barley, 1-2 bu.; (2) Oats, 1-2 bu. and Barley, 1 bu.; (3) Oats, 1-2 bu. and Barley, 1 1-2 bu.; (4) Oats, 1 bu. and Barley, 1-2 bu.; (5) Oats, 1 bu. and Barley, 1 bu.; (6) Oats, 1 bu. and Barley, 1 1-2 bu.; (7) Oats,

1 1-2 bu. and Barley 1-2 bu.; (8) Oats, 1 1-2 bu. and Barley, 1 bu.; (9) Oats, 1 1-2 bu. and Barley, 1 1-2 bu. This entire experiment was conducted in three places in our experimental grounds in 1900, and again in 1901, and in two places in 1902. In the average results for the three years, the three mixtures which produced the greatest yields of grain per acre were as follows:

1 bushel of Oats and 1 bushel of Barley, 2,201 pounds; 1 bushel of Oats and 1 1-2 bushel of Barley, 2,178 pounds; and 1 bushel of Oats and 1-2 bushel of Barley, 2,161 pounds. In yield of straw per acre, the three mixtures here mentioned and the mixture of 1 1-2 bushels of Oats and 1 1-2 bushels of Barley per acre produced the greatest average yields. The lowest average yield of grain per acre was produced by the heaviest seeding, and the second lowest by 1 1-2 bushels of Oats and 1-2 bushel of Barley per acre.

Barley and Oats, with Wheat, etc. Although the experiment described in the first paragraph under the last general heading showed that various combinations of oats, barley, spring wheat, and peas had been used in combination for the production of grain, we wished to conduct the experiment still further to ascertain whether a mixture of oats and barley which had given good results could be improved by the addition of some other grain. An experiment was, therefore, conducted in 1902 by sowing a mixture of 1 bushel of oats and 1 1-2 bushels of barley per acre as a basis of comparison. For each of the other mixtures, the same quantity of oats and barley was used, and, in addition, 1-2 bushel per acre of the following grains: Wild Goose spring wheat, Emmer, Grass Peas, and Flax. The experiment was conducted in duplicate. The average results of the two tests for 1902 were as follows: (1) Oats and Barley, 2,183 pounds; (2) Oats, Barley, and Spring Wheat (Wild Goose), 2,273 pounds; (3) Oats, Barley, and Emmer, 2,207 pounds; (4) Oats, Barley, and Grass Peas, 2,159 pounds; (5) Oats, Barley, and Flax, 2,180 pounds per acre. It will, therefore, be seen that in this experiment, which has been conducted for only one year as yet, the greatest yield was produced by adding a small quantity of Wild Goose Spring Wheat to the mixture of oats and barley.

Twelve Kinds of Grain Grown in Combination. In order to ascertain how different varieties of farm crops would stand crowding, twelve sorts were selected and equal quantities of seed were mixed together and sown in combination. The experiment was conducted in duplicate. After the crops were harvested and threshed, the grain was carefully examined. The twelve varieties produced grain in the following order, starting with the largest production and finishing with the smallest: Mandscheuri Barley, Joanette Oats, Black Hulless Barley, Siberian Oats, Rye, White Hulless Barley, Emmer, Wild Goose Spring Wheat, Prussian Blue Peas, Flax, Grass Peas, and Common Vetches.

Another somewhat similar test, consisting of ten plots, was also made; but the detailed results have not yet been made out; so they will be held over for future publication.

Treatment of Oats and Winter Wheat for Smut.

Great damage has been caused in Ontario during recent years by the loose smut of oats and the stinking smut of wheat. In order to glean information regarding the relative values of several treatments which are recommended for the prevention of smut, experiments have been conducted at the College by making a practical application of these treatments and

then watching the results carefully. The results here given for oats are for one year only, but for wheat they are for the average of four years.

Treatment of Oats for Loose Smut. Two varieties of oats were selected in the spring of 1902, and uniform samples from each variety were submitted to special treatments, with the object of killing the spores of smut adhering to the grain. The various treatments were as follows:

(1) Immersion in Hot Water. For this treatment, the grain was placed in a bag, which was then immersed in water at about 115 degrees F. Soon afterwards it was placed in water which was kept at a temperature between 130 degrees and 135 degrees F. The grain was occasionally stirred and was allowed to remain in the water for a period of fifteen minutes. It was then spread out on a clean floor to dry, where it was stirred occasionally.

(2) Immersion in Bluestone Solution for Five Minutes. For No. 2 treatment, a strong solution was made by dissolving one pound of Copper Sulphate (Bluestone) in one gallon of water, and then immersing the oats in the solution for a period of five minutes.

(3) Immersion in Bluestone Solution for Twelve Hours. In this treatment, the bluestone solution was made by dissolving one pound of bluestone in 25 gallons of water, and the oats were immersed in this solution for a period of twelve hours.

(4) Sprinkling with Bluestone Solution. This solution was made by dissolving one pound of bluestone in 10 gallons of water, which was used for sprinkling over the oats until they were thoroughly moistened after being carefully stirred.

(5) Immersion in Potassium Sulphide Solution. The potassium sulphide treatment consisted in soaking the seed for two hours in a solution made by dissolving 8 pounds of potassium sulphide in 50 gallons of water.

(6) Immersion in Diluted Formalin. The solution of formalin used for the immersion process was made by pouring one-half pint of the formalin into 21 gallons of water, and the seed oats were immersed in the solution for twenty minutes.

(7) Sprinkling with Diluted Formalin. One-half pint of formalin was poured into 5 gallons of water. The oats were then sprinkled with this solution and carefully stirred until the grain was thoroughly moistened.

(8) Untreated. One sample of oats of each variety was left untreated in order that the influence of the various treatments might be observed.

Eight lots of oats of each variety were, therefore, used for this experiment. After the treatments had been completed a few hours, the oats were carefully sown on sixteen separate plots. Each plot was exactly one square rod in size. Between the 7th of July and the 6th of August, eight careful examinations were made, and all the smutted heads in each plot were removed and counted. The following table gives the average results in the percentage of smutted heads of oats from each treatment:

Treatments.	Percentage of Smutted Heads of Oats.
1. Immersion in hot water	.0
2. Immersion in bluestone solution for five minutes	1.7
3. Immersion in bluestone solution for twelve hours	.6
4. Sprinkling with bluestone solution	.9
5. Immersion in potassium sulphide solution	3.4
6. Immersion in diluted formalin	.0
7. Sprinkling with diluted formalin	.0
8. Untreated	5.5

From the results here presented, it will be seen that where the oats

were untreated, 5 1-2 per cent. of the crop was destroyed by smut; and also that the treatments with hot water and formalin were very effective. As the market value of oats throughout Ontario for the past twenty years has been upwards of $20,000,000 a year, it will be seen from the above results that it is possible to make a difference of about $1,000,000 in the value of oats in Ontario in a single season by carefully treating the seed, and destroying the smut spores before the oats are sown.

Treatment of Winter Wheat for Stinking Smut. In the average of four years' tests, seed wheat infested with smut spores produced grain containing the following number of smut balls per pound of wheat: Untreated, 456; treated with potassium sulphide, 11; treated with copper sulphate (Bluestone), 2; and treated with hot water, 1.

The copper sulphate (Bluestone) treatment consisted in soaking the seed for twelve hours in a solution made by dissolving one pound of copper sulphate in 24 gallons of water, and then immersing the seed for five minutes in lime water, made by slacking one pound of lime in 10 gallons of water. The hot water treatment consisted in immersing the wheat for fifteen minutes in water at 132 degrees F. After each treatment the grain was spread out and stirred occasionally until dry enough to sow.

Methods of Cultivation.

An interesting experiment has been under way for two years in cultivating land in different ways for oats and barley. The four methods of cultivation followed at the time when the grain was sown were as follows: (1) Cultivated 6 inches, drilled, rolled, and harrowed; (2) Cultivated 3 inches, drilled, rolled, and harrowed; (3) Cultivated 3 inches, drilled and rolled; and (4) Cultivated 3 inches, and drilled. The results of these experiments are somewhat irregular, owing, no doubt, to the peculiar weather conditions of the last two years, and especially those of 1902. This experiment will likely be repeated for several years, and in time we hope to obtain results which may prove of some practical value.

A Comparative Test of Ten Different Classes of Grain.

Much has been done in an experimental way in testing different varieties of nearly all classes of farm crops. But very little has yet been done

Varieties.	Date of ripening.	Average height.	Amount lodged.	Amount of rust.	Yield of straw per acre.	Yield of grain per acre.
		inches.	per cent.	per cent.	tons.	lbs.
Emmer	Aug. 12	35	1	1	1.7	2334
Joanette Oats	" 7	35	1	5	1.5	2217
Mandscheuri Barley	July 30	35	3	2	1.3	2113
Wild Goose Spring Wheat	Aug. 25	42	1	2	1.8	1853
Black Hulless Barley	July 29	28	9	3	1.2	1825
Alaska Oats	" 30	37	2	4	1.3	1783
White Hulless Barley	" 29	28	12	4	1.1	1541
Spring Rye	Aug. 12	48	.....	2	1.6	1364
Prussian Blue Peas	Sept. 2	52	.....	.....	2.5	1279
Common Vetches	" 3	41	...	.....	2.0	1040

to ascertain the comparative yields of leading varieties of the different classes of farm crops under similar conditions. An experiment was conducted at the College in 1902 for the first time, in order to obtain some

definite information regarding the comparative yields of different classes of farm crops when grown and handled under as nearly uniform conditions as possible. The seeding took place on April 24th, and the experiment was conducted in duplicate. The following table gives the average results of growing ten varieties of farm crops under similar conditions and in duplicate in 1902.

It will be seen from the results here presented that the Emmer produced the greatest amount of grain, the yield being 117 pounds per acre more than that produced by the Joanette oats, and 221 pounds per acre more than that produced by the Mandscheuri barley. The grain of the Emmer is somewhat similar to that of the Wild Goose spring wheat; but it is enclosed in a hull somewhat resembling the hull of the oat. A more detailed description of Emmer is given further on in this report. Of the crops under experiment, the Hulless barleys were the earliest, and the common vetches were the latest to mature. The White Hulless and the Black Hulless varieties of barley possessed short, light, weak straw, as will be seen from the table of results. This experiment will likely be repeated in future years.

As some of the same varieties of crops were distributed throughout Ontario in the spring of 1902 for co-operative experiments, a reference to the results obtained will be interesting for comparison with the results at the College. It should be understood that the crops grown throughout Ontario were the averages of a large number of tests made on separate farms. The average soils on which any one crop would be grown would, therefore, not be exactly the same as the average soils used for the experiments with other crops.

Crops.	Tons of Straw per acre.	Lbs. Grain per acre.
Emmer	1.9	2,126
Siberian Oats	1.7	1,737
Mandscheuri Barley	1.6	1,672
Black Hulless Barley	1.5	1,536
Alaska Oats	1.4	1,398
Wild Goose Spring Wheat	1.7	1,302
White Hulless Barley	1.4	1,278
Early Britain Peas	1.2	1,166

It will be observed that the comparative order in yield of grain per acre throughout Ontario was very similar to that at the College.

Varieties of Spring Wheat for Flour Production.

Different classes of spring wheat are now grown in the experimental grounds and throughout Ontario for three distinct purposes, viz.: (1) For the production of flour, such as the Red Fife variety; (2) For the production of macaroni, such as the Wild Goose variety; and (3) For the production of food for live stock, such as the Russian Emmer, or the red variety of Spelt. As a result of the experiments in testing varieties of spring wheat for the production of flour, we have found the Red Fern and the Red Fife to be among the best varieties. These are old standard sorts, which compare very favorably with other varieties when both yield and quality of grain are taken into consideration. The Colorado, also called the Speculation or Thick-set, yields a little more than the varieties here mentioned, but possesses grain which is somewhat softer. Several new varieties were imported from Germany, the Argentine Republic, and from other places in-

1902. The results of the tests for one year show that a few of these varieties give fairly good returns, viz., Rolben (Ger.), 24 bu.; and Climax (U. S.), 16 bu. per acre.

Macaroni Wheat.

Owing to the foreign demand within the past few years for Wild Goose spring wheat for use in the manufacture of macaroni, an increased interest has been aroused in those varieties of spring wheat specially suited for macaroni manufacture. The Wild Goose variety is the only one generally known throughout the Province of Ontario suitable for this purpose. For ten years in succession, six varieties of macaroni wheats have been under experiment at the College. The average of ten years' results in yield of grain per acre are as follows: Wild Goose, 38.4 bu.; Medeah, 33.8 bu.; Bart Tremenia, 33.4 bu.; Sorentina, 33 bu.; Algiers, 31.1 bu.; and Ontario, 20.9 bu. per acre. In average weight per measured bushel, only two varieties exceed the standard of 60 pounds, namely, the Wild Goose, 61.1, and the Bart Tremenia, 60.8 pounds. The Medeah, however, comes next, with only about two-fifths of a pound per measured bushel under the standard. The Medeah is a very early variety, and on some soils and under certain conditions, may surpass the Wild Goose variety; but for general cultivation throughout the Province, there is no other variety grown which is likely to give so good satisfaction for growing to export for macaroni manufacture as the Wild Goose wheat.

Varieties of Spring Wheat for Feeding Live Stock.

Two classes of spring wheat, which are distinct from one another as well as from those types of spring wheat which are particularly grown for the production of flour or macaroni, are grown specially for the production of food for live stock. These two classes will be taken up under the separate headings of Spelt and Emmer.

Spelt (*Triticum spelta*) is a cereal which in appearance is intermediate between wheat and barley, but in reality is one of the types into which wheat is divided. It is a native of the countries near the Mediterranean Sea. At the present time, it is grown principally on the poorer soils in Switzerland, Southern Germany, and Northern Spain. It is also grown at an elevation in Switzerland where the common wheat (*Triticum staivum*) will not thrive. For general cultivation, it is considered much inferior to the finer varieties of wheat. The head is open, narrow, bearded or bald, and is usually very long. When the grain is threshed, the head breaks into pieces at the different joints or nodes, leaving the grain still clasped firmly by the chaff. In order to make a separation of the chaff from the seed, special machinery is required. The grain is medium hard, and somewhat compressed at the sides.

To find out the value of Spelt for growing in Ontario, we have imported at different times no less than ten varieties from Switzerland, Russia, Germany, the Argentine Republic, and the United States. Two of these varieties proved entire failures, two others gave poor results, and the other six varieties yielded moderately well. As the grain is enclosed by a chaff somewhat similar to oats, and weighs only about 40 pounds per measured bushel, the results here presented are given in pounds, instead of bushels of grain per acre. One of the best varieties of Spelt has now been grown in the experimental plots for four years, and has given

an average yield of 1,276 pounds of grain per acre. The yields per acre of the varieties of Spelt grown in 1902 were as follows: Red Spelt, 1,661 pounds; Alstroum Spelt, 1,466 pounds; German Spelt, 1,420 pounds; and White Summer Spelt, 1,263 pounds. The grain as here reported contained the following percentages of hull: Red Spelt, 32 per cent.; Alstroum Spelt, 33 per cent.; German Spelt, 28 per cent.; and White Summer Spelt, 31 per cent. A considerable amount of the grain grown throughout Ontario under the name of Spelt is improperly named, as it belongs to a different species of wheat known as Emmer.

Emmer (*Triticum dicoccum*) is a cereal which represents a different type of wheat from any of those already described in this report. It is grown in Russia, Germany, Switzerland, Spain, France, Italy, and to a slight extent in some other countries. In Russia alone, about sixteen million bushels are produced annually.

As in the case of Spelt, the grain of the Emmer is tightly enclosed within the chaff, from which only a small portion is separated, even in the process of threshing. In comparison with the Spelt, however, the heads are much shorter and more compact, and the grain is more triangular in form and very much harder. The spikelets of the Emmer overlap each other like shingles on a roof, which makes the head close, smooth, and regular. The heads are nearly always bearded and the chaff is usually harder than that of the Spelt. The portion of the stem adhering to the spikelets after threshing is much smaller and more pointed in the Emmer than in the Spelt. The spikelets of the Emmer are flattened on the inner side, while those of the Spelt are arched. Emmer is considered a very hardy plant, being much superior to the Spelt in this respect.

Emmer has been grown in the Experimental department for three years, and it has produced very heavy yields of grain per acre. The yields in each of the past three years are as follows: 1900, 2,608 lbs.; 1901, 2,129 lbs.; 1902, 2,252 lbs.; thus making an average of 2,327 lbs. per acre. The weight per measured bushel was 43.8 lbs. in 1900; 33.8 lbs. in 1901, and 36.6 lbs. in 1902, the average being 38 lbs' per acre. It will, therefore, be seen that the average yield of Emmer per acre for the past three years has been upwards of 60 bushels per acre by measure. The grain of Emmer when threshed has a less percentage of hull than that of Spelt, the average of the former being about 25 per cent., and that of the latter, 30 per cent., in the result of the experiments conducted at the College. Emmer is very much freer from rust, but is a little weaker in the straw than Spelt. On the whole, the Emmer has given much better results than Spelt in the experiments at the College.

Emmer was distributed for co-operative experiments throughout Ontario in 1901, and again in 1902, and the yields produced throughout the Province were very large. From the results of our experiments with Emmer, we believe that it will be more generally grown throughout Ontario for the production of straw of good quality and of grain to be ground for feed for live stock. The cereal which is now grown in many localities throughout Ontario under the name of Spelt is, in reality, not Spelt, but Emmer.

Varieties of Spring Rye.

Six varieties of spring rye were grown in the experimental plots in the spring of 1902. Two of these were foreign varieties, grown this season for the first time, and they gave very poor results, one yielding no grain what-

ever, and the other only about 3 bushels per acre. The other four varieties, however, gave very good results. The Dakota Mammoth, Prolific Spring, and Common varieties each yielded about 34 bushels per acre, while the Colorado Giant produced about 29 bushels per acre. These four varieties have been grown from three to five years, with the following average results in yield of grain per acre: Dakota Mammoth, 40.2 bu.; Prolific Spring, 36.9 bu.; Common, 34.9 bu.; and Colorado Giant, 25.8 bu.—the weight of rye being 56 lbs. per measured bushel.

Varieties of Oats.

Seventy-two varieties of oats were grown in the experimental plots in 1902. A few of these varieties have now been tested under similar conditions for twelve to fourteen years in succession. In the average results for twelve years, the yield per acre of the Siberian variety has been 88.6 bushels, and that of the American Banner, 84.7 bushels. Although the Banner gave an average vield of nearly one bushel per acre more than the Siberian in 1902, the Siberian has surpassed the Banner by an average of nearly four bushels per acre for each of the past twelve years. These two are among the leading varieties for general cultivation throughout Ontario. The Oderbrucker, Probsteir, Waterloo, Bavarian, etc., have also made good records in the average results over a long series of years.

Twenty-two varieties of oats were grown in the experimental plots in 1902 for the first time. Most of these were imported from Germany, England, Scotland, the Argentine Republic, and the United States. The following are the yields per acre produced by some of these newly imported varieties: Zoll-inholtserklarung (Ger.), 98 bu.; Leutewitzer (Ger.), 89 bu.; Tartar King (Eng.), 82 bu.; Waverley (Eng.), 80 bu.; Gold Finder (Eng.), 73 bu.; and Pioneer (Eng.), 67 bu. None of these varieties, however, yielded so heavily as either the Siberian or the American Banner.

Varieties of Six-rowed Barley.

The varieties of six-rowed barley which produced the largest yields of grain per acre in 1902 were as follows: Mandscheuri, 86 bu.; California Brewing, 80 bu.; Common Six-rowed, 77 bu.; and Oderbrucker, 75 bu. Among fifteen varieties which were imported and grown in 1902 for the first time, the following kinds gave the largest yields of grain: Hanna No. 5590 (Iowa), 72 bu.; New Awnless, 71 bu.; and Triumph, 70 bu.

Of the ten varieties of six-rowed barley which have been grown for nine years in succession, the greatest yields were, in the order given, produced by the Mandscheuri, California Brewing, Scotch Improved, Common Six-rowed, and Oderbrucker; and the lightest yield per acre was produced by the Success, a beardless variety.

Varieties of Two-rowed Barley.

Two-rowed barley is grown but to a very limited extent throughout Ontario. For certain purposes, however, it fills an important place among the cereal crops of the Province. It is becoming more and more the practice to grow grains in mixture for the production of both green fodder and grain. Among eleven mixtures of grain tested for a period of six years, it was found that oats and barley produced the largest yield of threshed grain per acre. In order, however, to secure a crop which ripens uniformly,

it is necessary to select a late variety of barley to be used with an ordinary variety of oats, or a very early variety of oats to sow with an ordinary variety of barley in order to have the two mature at the same time. The Chevalier has been found to be an admirable variety to mix with either the Siberian or the Banner variety of oats. In the results of testing eight varieties of two-rowed barley for a period of nine years, the French Chevalier and the New Zealand Chevalier varieties each produced 62 bushels per acre, and were among the greatest yielders of all the two-rowed barleys. The Duckbill variety gave an average yield of about three bushels per acre less than either of the strains of the Chevalier barley.

Varieties of Hulless Barley.

A considerable amount of Hulless barley is grown in some parts of Ontario, especially in those sections where the "pea-bug" (weevil) has been doing serious damage to the pea crop in recent years, and where the farmers are using the Hulless barley as a partial substitute for the pea crop. The yield of grain of the Hulless barley is usually very good; but, generally speaking, the straw is weak. When sown with oats, however, the crop seems to stand up rather better than when sown alone.

In 1902, eleven varieties of Hulless barley were under test at the College, the greatest yields being produced by the following: Guy-Mayle, 65 bu.; Black Hulless, 61 bu.; Hungarian, 60 bu.; and Winnipeg No. 2, 58 bu. – the standard of 60 pounds per measured bushel being used in every case. Eight of these varieties have now been grown for nine years in succession, with average yields per acre as follows: Guy-Mayle, 48 bu.; Black Hulless, 45 bu.; Purple, 44 bu.; Guymalaya, 42 bu.; Winnipeg No. 2, 41 bu.; Hungarian, 41 bu.; Large Skinned, 40 bu.; and Smooth Hulless, 38 bu. In average weight per measured bushel for the nine years, the Purple variety went 63 and the Black Hulless 62 pounds.

Winter Barley.

Winter barley has been tested in the plots more or less in each of the past twelve years. When the winters have been unfavorable, however, the barley has usually been winter killed, but in those seasons in which the barley could survive the winter the results have been exceedingly good. In fact, the average yield per acre of winter barley produced in each of five favorable years has been 72.5 bushels per acre. If winter barley could be depended upon to survive the average Ontario winter, it would likely surpass the best spring varieties in yeld of grain per acre. Unless we can secure some hardier varieties, however, than we have at present, there is a good deal of risk in sowing large areas with winter barley in Ontario.

Varieties of Winter Wheat.

Ninety-five varieties of winter wheat were grown at the College this year. The ten varieties giving the greatest yield of grain per acre, starting with the highest, were as follows: Extra Early Windsor, Dawson's Golden Chaff, Imperial Amber, Pedigree Genesee Giant, Prize Taker, Economy, New Columbia, White Golden Cross, Early Ontario, and Johnson. The Extra Early Windsor very closely resembles the Dawson's Golden Chaff variety. Those varieties possessing the stiffest straw were the Dawson's Golden Chaff, Extra Early Windsor, Clawson Longberry, and American Bronze.

Experiments have shown that the sprouting of wheat greatly injures it for seed as well as for flour production. All of the varieties at the College this season were more or less sprouted before they could be harvested. Those varieties which sprouted the least were the Red Cross, McPherson, Wisconsin, Triumph, and Reliable, and those which sprouted the most were Pedigree Genesee Giant, Early Arcadian, and Oregon. Fifty-seven varieties were sprouted less and thirty-seven varieties were sprouted more than the Dawson's Golden Chaff. The varieties without beards were sprouted as badly as those with beards, and the hard wheats were sprouted slightly more than the softer varieties. The white wheats, as a class, however, were sprouted much worse than the red varieties.

A deputation of ten persons from the Dominion Millers' Association visited the College last summer, and, after examining the different varieties of winter wheat, recommended that the following varieties be grown extensively in Ontario: (1) Red Wheat—Michigan Amber and Turkey Red; (2) White Wheat—Early Genesee Giant and Bulgarian.

Miscellaneous Experiments with Winter Wheat.

Quantities of Seed per Acre. From sowing one, one and one-half, and two bushels of winter wheat per acre for six years, average yields of 40.2 bu., 43.3 bu., and 43.9 bu. per acre, respectively, were obtained. As two varieties of wheat were used each year, these averages represent twelve distinct tests.

Methods of Sowing. Winter wheat which was sown broadcast by hand gave practically the same results as that which was drilled in with a machine in the average results of tests made for eight years. The land was in a good state of cultivation in every instance.

Dates of Sowing. Winter wheat sown at the College during the last week in August or the first week in September yielded better than that sown at a later date in the average results of tests made continuously for eight years. In 1902 the highest average yield was obtained from sowing on September 2nd, 1901.

Preparation of the Land. In an experiment conducted for four years, winter wheat grown on land on which a crop of field peas was used as a green manure, produced an annual average of 22.1 per cent. more wheat per acre than on land where a crop of buckwheat was plowed under. In another experiment, which was carried on for one year, winter wheat grown on land prepared from clover stubble produced 20.7 per cent. more wheat per acre than on land prepared from timothy stubble. In a two years' test with commercial fertilizers, an application of 160 pounds of nitrate of soda per acre increased the yield of wheat 18.8 per cent., or 7.2 bushels. The present price of nitrate of soda is about $65 per ton.

Value of Seed from Wheat Cut at Different Stages of Maturity. For seven years in succession five plots of each of two varieties of winter wheat were sown at the same time in the autumn, and cut at five different dates in the following summer—a week being allowed between each two dates of cutting. Seed from each of the seventy cuttings was sown and the crop therefrom was harvested when ripe. In the average results of these tests it was found that the heaviest weight of grain per measured bushel and the largest yield of both grain and straw were produced from seed taken from the crops which had become very ripe by remaining uncut for the longest period of time.

Winter Rye.

Five varieties of winter rye have been under experiment at the College within the past eight years. Only three kinds, however, were grown in the plots in 1902, namely, Common, Monster, and Mammoth. The Monster and the Mammoth varieties are similar in many respects, although the Mammoth variety has surpassed the other slightly in yield of grain per acre. The average results of the three varieties for four years are as follows: Mammoth Rye, 57.4 bushels per acre; Monster, 54.9; and Common, 52.

Varieties of Buckwheat.

Three varieties of buckwheat have been grown in our experimental grounds for seven years in succession, and the average results of those seven years, it is found that the Japanese has given 20.8 bushels; the Silver Hull, 17.8 bushels; and the Common Grey, 16 bushels of grain per acre. In the production of straw, it is also found that the Japanese is the heaviest yielder, producing an average of 2.9 tons per acre; while the Silver Hull produced 2.8 tons, and the Common Grey, 2.6 tons.

Varieties of Corn for Grain.

For three years in succession, nineteen early varieties of flint and dent corn have been carefully tested for the production of grain. The yields in 1902 were less than in either of the two previous years. The greatest yields this year were produced by the Dakota Gold Dollar (44.8 bu.), Longfellow (44.3 bu.), Farmers' Friend (41.5 bu.), Bailey's Mahogany (41.3 bu.), and Canada Yellow (40.8 bu.) The varieties which produced the greatest yields of shelled corn per acre in the average of three years were the King Phillip, 64.2 bu.; Genesee Valley, 62.7 bu.; North Star Yellow Dent, 61.1 bu.; Pride of Canada, 59.9 bu.; and Longfellow, 58.9 bu. The North Star Yellow Dent variety, which gave such excellent results in 1900 and in 1901, did not seem to be so well suited to the peculiar conditions of weather which prevailed throughout the growing season of the present year. There is a considerable amount of difference in the comparative percentage of cob to ear in the different varieties, as, for instance, in the average of the past three years the Farmers' Friend and the Salzer's Early Ripe varieties each gave 81 per cent. of grain from the ears, while the Burlington Hybrid and the Compton's Early varieties gave only 73 per cent. of grain from the ears. In 1902, the amount of grain as compared with the unshelled corn varied from 81 per cent. to as low as 62 per cent., according to the variety.

Varieties of Sunflowers.

Seven varieties of sunflowers have been grown in the Experimental department within the past few years. The two principal objects in view were to ascertain the comparative yields of the different varieties in the production of heads for putting into the silo with corn, and to determine the comparative yields of seed per acre. Several of the varieties gave rather poor results, and were dropped from the list. Three kinds, however, have given good yields, and have now been under experiment for a period of five years. The following are the average yields of seed per acre: White Beauty, 66.3 bu.; Mammoth Russian, 64 bu.; and Black Giant, 57.5 bu. In 1902, the white Beauty gave a very heavy yield of seed per acre, viz., 80.9

bushels, while the Black Giant produced 67.5 bushels, and the Mammoth 60.7 bushels per acre. In reckoning the yield per acre, the standard of twenty pounds per measured bushel was used throughout. In yields of heads per acre, the Black Giant produced the largest in 1902, and also in the average of the five years in which these varieties were under experiment. A person wishing to grow sunflowers will not make a mistake by selecting any one of the varieties here mentioned.

Varieties of Millet for Seed.

In 1894, 1898, 1900, 1901, and 1902, different varieties of millet were allowed to ripen, to ascertain the comparative results of the different varieties in yield of seed per acre. In the average results for these years, the California and the Siberian varieties have both produced very large yields of seed, each variety surpassing the Hungarian Grass by about 4 bushels per acre. The Japanese Panicle Millet has made high records in yield of seed per acre in some seasons; but, as it is somewhat slower in maturing than other varieties, it gives the best results for seed production in those seasons in which the growth is not prolonged over so long a period as it was in 1902. The varieties here referred to have given an average yield of seed per acre about double that produced by the Common millet.

Field Peas.

A bulletin has recently been prepared by Prof. Lochhead and myself on the subject of "Peas and the Pea Weevil." This bulletin has been forwarded to the Department of Agriculture, Toronto, and will likely be printed and distributed in a short time. For a full account of the results of past experiments with field peas, the reader is, therefore, referred to the bulletin here mentioned.

The following gives the conclusion and recommendations as set forth in the bulletin regarding the eradication of the pea weevil in Ontario:

Conclusion. While we believe in the value of fumigation with carbon bisulphide in the fight against the pea weevil, we as firmly believe that it is not practicable to fumigate all the weevils which attack the peas grown in Ontario annually on an area of about 500,000 acres.

Recommendations:

(1) That the growing of both field and garden peas (to be ripened) in the weevil-infested districts of Ontario be discontinued for the next two years, and that such crops as Grass peas, Early Yellow Soy beans, Emmer (improperly called Spelt), mixed grains, etc., be substituted;

(2) That the acreage of both field and garden peas of the very best varieties be largely increased in those sections of the Province where there is no pea weevil;

(3) That seedsmen, farmers, and others send no infested peas into those districts of Ontario where the pea weevil does not exist;

(4) That if any persons persist in growing and ripening peas in the infested districts, it be insisted that they make the best possible use of the fumigation method; and

(5) That farmers, gardeners, seedsmen, millers, exporters, importers, and all others who have anything to do with the growing or the handling of peas in Ontario, co-operate heartily with one another and with the Government in the effort to eradicate the pea weevil from Ontario within the next two years.

No varieties of peas were sown in the early spring of the present year. A few varieties, however, were sown in the experimental plots on the 25th of June, in order to find out whether the pea weevil would damage the crop when sown at a date so late in the season. As a result of the experiment, it was found that the highest yield per acre produced by any one of the fifteen varieties was 13 bushels; and that only five of the varieties gave upwards of ten bushels per acre. The small yields can, of course, be accounted for by the late sowing, and by the very unfavorable season. A very important feature of this experiment is that the New Zealand Field variety of peas, which gave the largest yield of grain per acre, produced peas of which 71 per cent. were infested with the pea weevil. It will, therefore, be seen that by sowing peas even as late as the 25th of June, we cannot expect to escape the ravages of the pea weevil in those sections which are badly infested with this troublesome insect.

Grass Peas.

The Grass pea is a leguminous plant, which produces long, flat vines; slender leaves; white blossoms; medium-sized pods; and hard, angular, white, or greenish white, seeds. It is entirely proof against the attacks of the pea weevil. In many respects, it resembles the Bitter Vetch (*Lathyrus sativus*) of Europe, which, however, has blue flowers and brown seeds. It also appears to be free from the poisonous principle which the Bitter Vetch is said to possess. This is borne out by the scientific investigations which have been made, and by the extensive and satisfactory use of the Grass peas as a food for farm stock. They are highly prized as a regular farm crop in some sections of Southern Ontario, where they have been extensively grown and fed for several years. They have been largely used as a substitute for the ordinary field peas in some of those districts in which the pea weevil has been doing serious damage for many years. In 1902, however, Grass peas, as well as nearly all other leguminous crops, were a partial failure, owing to the cold, wet weather of the past summer. The yield of the Grass peas in 1901 was also below the average in some localities, owing to the very hot weather at the time of blossoming. For feeding purposes, they seem to compare favorably with the ordinary field peas. They are usually sown alone, but sometimes with oats and barley. The crop may be used as green fodder, or as hay, or may be ripened for the production of grain, for which purpose, one and one-half bushels of seed per acre is usually sown with a grain drill. The straw is richer than that of any of the ordinary grain crops. The peas are very hard; but, when ground, they make a rich meal, that is relished by cattle, sheep, and hogs. The meal of Grass peas, being rich in flesh-forming constituents, should form not more than one-third of the entire meal ration for farm stock. In this respect, it is very similar to the meal of ordinary field peas. Grass peas, however, cannot take the place of garden peas for table use, nor of field peas for the export trade.

Grass peas have been grown in the trial grounds at the College for nine years, and have given good results, except in 1902, when they were a partial failure, owing to the cool, wet weather, and excessive rainfall. In the average results of tests made for a period of seven years, it is found that the annual yield of grain has been 25.7 bushels, and the yield of straw 2.2 tons per acre. In 1900, the yield was slightly over 43 bushels per acre. The grain has been exceptionally heavy, the average weight per measured bushel being about 64 pounds. In comparing the results of Grass peas with

the Golden Vine peas (the common, small, white pea of Ontario) for a period of seven years, we find that the latter gave an average annual yield of grain of 1.4 bushels per acre more than the former; but that the former gave a yield of 4-5 of a ton of straw per acre, and grain which weighed fully 4 pounds per measured bushel more than the latter.

The average results of twenty-seven co-operative experiments conducted throughout Ontario in 1901 show that the Grass peas gave about 3-4 of a bushel per acre less than the Early Britain variety, and 1-2 a bushel per acre more than the White Wonder variety.

To make a comparative test of the value of Grass peas and Common Tares, or vetches, for green fodder, seed of these varieties was distributed throughout Ontario for co-operative experiments, in the years 1897, 1898, 1899, 1900, and 1901. The average results of all the carefully conducted experiments for the five years, show that the Grass peas gave a yield of 6.7 tons, and the common tares, or vetches, a yield of 6.8 tons per acre.

Egyptian Peas.

The Egyptian pea is a leguminous plant, grown extensively in the Mediterranean regions and in Central Asia. It has many common names, such as, Coffee Pea, Chick Pea, Idaho Pea, Gipsy Pea, etc., and is scientifically known under the name of *Cicer arietinum*. It has been used as a food for cattle, and also as an article for human food, for upwards of 3,000 years. The seed is somewhat larger than that of the common pea, and is enclosed in a short, thick, hairy pod, there being from one to two peas in each pod. The plant itself is seldom used, except as a soil renovator, but the yield of grain is large, when ground into meal, makes a very valuable stock food, fed in much the same way as cotton seed meal. The straw is of but little use. As a human food, the peas are used in various ways. The ripened grain is sometimes prepared for the table in much the same way that we prepare our Canadian peas for culinary purposes. It is also sometimes roasted and used as a substitute for coffee.

The average results from growing Egyptian peas in the Experimental Department show that there was a yield of one ton of straw, and of 35.6 bushels of grain per acre, and that the grain weighed a little over 62 pounds per measured bushel. It will, therefore, be seen that the Egyptian pea is a large yielder of grain. The crop is usually slow in maturing, requiring about two weeks longer to ripen than the ordinary field peas. As the plants are usually short in growth, the Egyptian peas are suitable only for very rich soil. As was the case with nearly all the leguminous crops, the Egyptian peas were a partial failure in 1902, owing to the unusual amount of cold, wet weather.

The Egyptian peas were distributed throughout Ontario for co-operative experiments for four years. Of 180 successfully conducted experiments, the average annual yield of grain was 21.1 bushels per acre, from which we infer that the Egyptian peas are not suitable for the average soil of the Province.

Cow Peas.

Nearly all the varieties of Cow Peas (*Vigna sinensis*) require such a long season of growth that they are suited only to the warm climate of the south. A few of the earlier kinds have been grown in the northern States, and have been tested at our Experiment Station at Guelph. We have not

as yet, however, found a variety upon which we can depend to produce ripened grain, as our season is short, and it is only in exceptional years that even the earliest varieties of Cow Peas will mature their grain.

Lupines.

Lupines have been grown more or less for several years, with varying results. In 1902, three varieties were planted, viz., the White, the Yellow, and the Blue. The Yellow and the Blue varieties produced very poor crops; but the White gave a yield of 17.2 bushels of grain, and 1.6 tons of straw per acre. This result is much higher than we have usually obtained from Lupines in past years. As a rule, the crop does not give very satisfactory results.

Vetches for Seed.

As Hairy Vetches have been doing so well as a fodder crop, and as the seed is very expensive, it is desirable to glean information regarding the possibility of producing seed of the Hairy Vetch in Ontario. In growing both the Hairy vetches and the Common vetches for the past three years, the results show rather the best yields from the Hairy vetches in 1900 given rather better results than spring seeding with the Hairy vetches for seed production. The average yield of seed produced by the Hairy vetches and in 1901, and from the Common vetches in 1902. Autumn seeding has has been a little over 7 bushels per acre. This is not a very large yield of seed, but when it is realized that the seed has been selling at from $5 to $7 per bushel, the return is large, even from the amount of crop which was obtained.

Lentils.

We have grown Lentils in our experimental plots for about five years, and find that the plants usually grow to a height of about 12 inches. The crop of green fodder produced is usually small, and the plants seldom ripen their seed. In 1902, the yield of seed per acre was only 125 pounds, or a little over 2 bushels. The past results from growing Lentils at the College indicate that the crop is not likely to give satisfaction in Ontario.

Horse Beans.

Several varieties of Horse Beans have been tested in our trial grounds within the past twelve years. In most seasons, however, the weather is so hot and dry that the crop turns black and dies. It has been only in exceptional years that this crop has been successful. In 1902, the rains were so frequent and the weather so cool that the Horse Beans did unusually well, the yield of grain being 29 bushels per acre, which is the greatest yield that we have ever obtained in any season since our experiments with this crop were started. As a rule, however, the Horse Beans have been a failure in the experimental plots at Guelph.

Varieties of Flax.

Two varieties of flax have been grown for six years, one for five years and one for two years. The East India White variety of flax, which was sown in 1901 for the first time, and was sown again in the spring of 1902,

has given very poor results. It is a very early variety, with short straw, and large(light-colored seeds. Its partial failure in 1901, and total failure in 1902, may be partly accounted for by the peculiar seasons. We intend to give it another trial next year. The results of the three varieties of flax successfully tested in 1902 are as follows : Manitoba, 10.8 bus.; Common, 15.7 bus.; and Russian, 10.5 bushels of seed per acre. In the average of the number of years that these varieties have been grown, we have obtained the following yields : Manitoba, 13 bus.; Common, 11.4 bus.; and Russian, 10.8 bushels per acre.

Varieties of Field Beans.

Although upwards of thirty varieties of field beans have been grown in our experimental grounds in some of the years past, the number for 1902 was limited to fifteen varieties. These were among the best kinds, as shown by the results of the previous experiments. The highest yields were produced by the Zealand Haricots, 26.1 bus.; White Wonder, 26 bus.; Medium or Navy, 25.3 bus.; Buckbee's Electric Tree, 25 bus.; and Pearce's Improved Tree, and Schofield Pea, each 24.8 bushels per acre. In weight per measured bushel, the results were quite high in 1902, the Buckbee's Electric Tree and the Burlinghame Medium each going upwards of 65 pounds. The majority of the varieties produced grain which weighed more than 64 pounds per measured bushel, and only three of the varieties produced grain which weighed less than 60 pounds per measured bushel.

In the average results of experiments conducted for six years, the following varieties produced the greatest yields per acre: White Wonder, 23.6 bus.; Day's Improved Leafless, 23.3 bus.; Medium or Navy, 23 bus.; Pearce's Improved Tree, 22.6 bus.; and Schofield's Pea, 22.5 bushels per acre.

Soy Beans.

The Soy bean (*Glycine hispida*) also known under the names of Soja Bean, Coffee Bean, Idaho Pea, etc., has been cultivated in Japan and China for a great length of time. The Soy bean is an annual legume, and the plants have an upright growth, and are almost completely covered with short hairs. The seed is generally sown at the rate of about one-half bushel per acre, in drills from two to three feet apart, which are cultivated in a manner similar to that of our Canadian beans. The crop is used for green fodder, or is allowed to ripen for the production of grain, which is exceedingly rich, and, when ground into meal, is considered about as valuable as cotton seed meal for stock feeding.

About twenty years ago, the Kansas Experiment Station imported from Japan fifteen varieties of Soy beans, carefully tested them at the Experiment Station grounds, and found that five of the varieties gave good results. About ten years ago, seed of these five varieties was grown in our own experimental plots.

Eight varieties of Soy beans have been imported and grown in our Experimental Department. Some of the varieties proved to be entirely unsuited for Ontario, owing to the long season required to reach maturity. The Early Yellow variety, however, has given good results as a grain producer, and the Medium Green variety for the production of green fodder. In the average results from growing the Early Yellow Soy beans for a period of seven years, 17 bushels of seed per acre have been obtained. In

the production of green fodder, the Early Yellow variety produced an average of 8 and the Medium Green variety an average of 9.3 tons per acre for the same length of time.

The Early Yellow Soy beans were distributed over Ontario last year for co-operative experiments, and the average yield of grain produced on thirteen Ontario farms was 21.4 bushels.

We believe it would be a decided advantage to Ontario farmers to grow Early Yelow Soy beans more generaly for the production of grain for feeding purposes, and Medium Green Soy beans for putting into the silo with corn.

Varieties of Potatoes.

One hundred and twenty-four varieties of potatoes were grown in the experimental grounds in 1902. A number of these varieties had been previously grown at the College, while others were grown for the first time from seed imported from England, Ireland, and the United States. Each of the following twelve varieties produced upwards of 300 bushels of potatoes per acre in 1902 : Empire State, 358 bus.; Molly Stark, 337 bus.; White Elephant, 331 bus.; Convoy, 326 bus.; Rural New Yorker No. 2, 325 bus.; The Daisy, 315 bus.; Rose's New Invincible, 310 bus.; Uncle Sam, 309 bus.; Salzer's Earliest, 307 bus.; New Queen, 305 bus.; and Carman No. 1, 301 bushels. There was a marked difference between the various kinds in regard to the percentage of marketable potatoes. Some of the varieties produced potatoes, nearly all of which were marketable, as, for instance, the following kinds produced crops of which upwards of 92 per cent. of the potatoes measured over one and a half inches in diameter: Empire State, 95 per cent.; English Bumpers, 95 per cent.; Holborn Abundance, 94 per cent.; Carman No. 2, 94 per cent.; Carman No. 1, 93 per cent.; Rural New Yorker No. 2, 93 per cent.; Adirondack, 93 per cent.; Early Fortune, 93 per cent.; White Pink Eye, 93 per cent. In comparison with these high percentages, we find that four varieties had less than 40 per cent. of their entire crop of a sufficient size for market use, viz.: Lady Finger, 27 per cent.; Gemmell's Seedling, 30 per cent.; New Main Crop, 38 per cent.; and Tremendous, 39 per cent. Owing to the many rains, it was necessary to spray the potatoes with Paris green four times for the destruction of the potato bettle. Bordeaux mixture used with the Paris green on two occasions in order to prevnt the potato rot. There was, therefore, only a small amount of rot in the potatoes grown in the experimental department this year, which was quite different from the experience of potato growers in many parts of Ontario, who did not spray their potatoes with Bordeaux mixture in the summer of 1902.

In the average results of twenty-one varieties grown for nine years in succession, the following produced the greatest yields per acre : Empire State, 244 bus.; Convoy, 242 bus.; Rose's New Invincible, 241 bus.; Rural New Yorker No. 2, 234 bus.; and American Wonder and White Elephant each 232 bushels per acre.

For two years, about two hundred varieties of potatoes were carefully tested for table quality. The Empire State was found to be one of the best varieties for table use, as well as for producing an abundant crop.

Six rows of each of ten very early varieties of potatoes were planted in the spring of 1902. Two rows of each variety were dug and tested at the end of nine weeks, two other rows at the end of twelve weeks, and the two remaining rows at the end of fifte

weeks after planting. In this experiment, which was conducted in duplicate, the following varieties produced the largest average yields of potatoes per acre at nine weeks after planting : Early Fortune, Early Andes, Stray Beauty, Six Weeks, Early Dominion, and Early Dawn; at the end of twelve weeks, the greatest average yields were produced by the Early Andes, Early Dawn, Early Dominion, Early Fortune, and Stray Beauty. At the end of the third and last digging, viz., at the end of fifteen weeks after the potatoes were planted, the varieties which gave the greatest average yields per acre were the Early Andes, Stray Beauty, Early Dominion, Howe's Premium, and Early Fortune.

Selection of Seed Potatoes.

For eight years in succession, an experiment has been conducted in planting whole potatoes of different sizes, the selections each year being made from the crop produced the year previous from a similar selection. The average results from a duplicate experiment conducted in 1902, which was the eighth year after the commencement of the experiment, are as follows: Large whole potatoes, 199 bus.; Medium sized whole potatoes, 173 bus.; Small whole marketable potatoes, 116 bus.; and very small whole unmarketable potatoes, 99 bushels per acre.

As the result of this and other experiments, we find that large potatoes, or large pieces of potatoes, produced greater yields than either small potatoes or small pieces. It has been found that large potatoes cut into pieces of about two ounces in weight give satisfactory results, when the amount of seed used, and the yield of potatoes produced, are both taken into account.

Planting One, Two and Four Pieces of Potatoes in Each Hill.

As the result of an experiment conducted for four years in succession in planting one, two, and four pieces of potatoes per hill, and using the same weight of seed in every instance, it has been found that larger yields and better results have been obtained where only one piece was planted in each place. The average results for the four years, which are very suggestive, are as follows : One piece in each hill, 221 bus.; two pieces in each hill, 202 bus.; and four pieces in each hill, 182 bushels per acre. The cutting of a potato tends to increase the number of stems produced, and when from two to four small potato sets are planted in one place, there is a greater number of stems produced than when one large piece is used. The average percentage of marketable potatoes from each of the three methods is as follows : One piece per hill, 73 per cent.; two pieces per hill, 67 per cent.; and four pieces per hill, 62 per cent. It seems as though a few large, vigorous stems give better results in both yield and quality of potatoes than a large number of small, weakly stems, which are almost sure to grow when more than one piece is planted in each hill.

Influence of Coating Cut Potatoes with Lime, Plaster, etc.

For several years in succession, an experiment has been conducted by cutting potatoes and planting them with and without being sprinkled with plaster and with lime. In 1902, two varieties of potatoes were submitted to this treatment, and the experiment was conducted in duplicate with each variety. The results for 1902 are similar to those of former years, and show

that those potato sets which have been sprinkled with plaster have given decidedly the best results, showing that the plaster had a marked influence in increasing the yield of potatoes in the experiments conducted at the College. In a similar experiment conducted throughout Ontario for three years, the results have shown a marked advantage from using plaster liberally in coating the potato sets immediately after they are cut.

Length of Time to Cut Potatoes Before Planting.

As a result of extensive experiments conducted at the College and throughout Ontario, it is found that under average conditions, it is decidedly better to plant potatoes immediately after they are cut, rather than to hold them four or five days before planting. As the result of experiments conducted for a period of eight years, we have obtained an average of 8 bushels per acre more from immediate planting than from the other method. The average percentage of marketable potatoes was also larger from immediate as compared with the delayed planting.

Potatoes Grown with Farmyard and with Poultry Manure.

An experiment was conducted in the experimental grounds in 1902 for the first time, to test the comparative values of ordinary farmyard manure and poultry manure for the production of potatoes. The experiment was conducted in duplicate. The following average yields of potatoes pere acre were obtained : Unmanured, 105 bushels; 5 tons of barnyard manure per acre, 144 bushels; 1 ton of poultry manure per acre, 125 bushels; and 2 tons of poultry manure per acre, 158 bushels.

Treatment of Potatoes to Destroy the Scab.

The scabby potatoes were immersed in a solution of corrosive sublimate for one and one-half hours, after which they were spread out to dry. They were then cut and planted in the usual way. The corrosive sublimate solution was made by dissolving corrosive sublimate in hot water in the proportion of two and one-quarter ounces of the former to two gallons of the latter. The solution was allowed to stand twelve hours, after which it was diluted with thirteen gallons of water. As the corrosive sublimate is very poisonous, the material itself should be looked after very carefully, and no potatoes which have been treated should be left unplanted.

Although there was a little scab on the potatoes produced from the seed which had been treated from the corrosive sublimate, the amount was only about two-fifths as much as that found on the potatoes which were untreated.

Different Methods of Treatment to Kill the Potato Beetle.

An experiment has been carried on in our trial grounds for seven years in succession by using different methods of treatment for destroying the potato beetle. The treatments used in all of these years have been Paris Green with water, Paris Green with plaster, and a preparation known as Potato Bug finish. These were used from two to four times each season. As a basis of comparison, one plot in every test was allowed to remain untreated. The average results of the experiments for the seven years go to show that the potatoes which were not treated produced an annual yield

of 75 bushels per acre; those treated with Potato Bug Finish, 119 bushels; those treated with Paris Green and plaster, 128 bushels; and those treated with Paris green and water, 133 bushels per acre. In five out of the seven years, the Paris green and water gave the highest yield per acre, and in the other two years the Paris geen and plaster gave a larger yield of potatoes than either of the other methods of treatment. In no instance did the potatoes which we treated with the Potato Bug Finish give so large a yield of tubers per acre as those treated with the Paris green in solution. During the five years from 1896 to 1900, the Potato Bug Finish gave fairly good results, but during the past two years the results from this preparation have been quite unsatisfactory.

In 1902, six lots, of each of two varieties of potatoes, were carefully selected and planted on twelve separate plots. After the potatoes had made sufficient growth, and the potato beetles (bugs) had made their appearance, five plots of each variety were treated in different ways to destroy the beetles, and one lot of each variety was left untreated as a basis of comparison. The five treatments were as follows : (1) Paris green and water, using one pound of Paris green in 96 gallons of water per acre; (2) Paris green with plaster, using one pound of Paris green in 38 pounds of plaster per acre. This mixture was applied to the potatoes in the dry condition; (3) Potato Bug Finish, which was applied dry at the rate of 20 pounds per acre; (4) Bug Death and water, using 32 pounds of Bug Death mixed in 96 gallons of water per acre; (5) Bug Death, used in the same proportion as in No. 4, but in the dry condition; and (6) untreated. Three applications were made with each treatment. In the autumn, the potatoes from each of the twelve plots were dug and weighed. The following are the average results in yield of potatoes per acre: (1) Paris green and water, 124 bus.; (2) Paris green with plaster, 123 bus.; (3) Potato Bug Finish, dry, 107 bus.; (4) Bug Death and water, 163 bus.; (5) Bug Death, dry, 169 bus.; and (6) Untreated, 68 bushels. The results of the different treatments were very similar for the two varieties of potatoes. The Bug Death is manufactured at Saint Stephen, N.B., and has recently been introduced into Ontario. 1902 was the first year that it was tested in our trial plots at the Agricultural College. It has certainly made an excellent record this season. The potato tops on which the Bug Death was applied were more vigorous in growth and greener in appearance throughout the season than those on which the other applications were made. The Bug Death was also very effectual in killing the beetles. The usual prices of these insectides when bought in quantity are about as follows : Pairs green, 20 cents per pound; Bug Death, 8 cents per pound; and Potato Bug Finish, 1 2-3 cents per pound. The cost, therefore, for the material used in the experiment conducted in 1902 was about as follows : Paris green, 60 cents per acre; Bug Death, $7.65 per acre; and Potato Bug Finish $1.00 per acre.

Varieties of Sugar Beets.

Sugar beets have been grown in Ontario to a limited extent for several years as food for farm stock. More recently, however, a great deal of interest was centred in the production of beets for the manufacture of sugar. Experiments have been carried on in the experimental department with different varieties of sugar beets for nine years. Some of these varieties were specially adapted to the production of sugar, and others to the production of food. In 1902, thirty varieties were carefully tested in the experimental department for production, and in the chemical department

for quality. These varieties represented beets for both agricultural and manufacturing purposes. Twenty-one of the varieties had been grown in the experimental plots in previous years, and nine of the varieties were grown in 1902 for the first time. Most of the new varieties were freshly imported from Germany, as being specially adapted to the production of a very high percentage of sugar. In 1900, and again in 1901, the sugar beets were planted in rows 26 inches apart, and the plants were thinned to a distance of 7.9 inches apart in the rows. In 1902, however, all the varieties were planted in rows 21 inches apart, and a distance of 7 inches was left between the plants in the rows. The following table gives the yield per acre of the different varieties which were grown in 1900, 1901, and 1902:

Varieties.	Yield of roots per acre.			
	1900. Tons.	1901. Tons.	1902. Tons.	Average Tons.
1. Red Top	24.25	19.63	26.81	23.56
2. New Danish Improved	19.10	18.60	27.88	21.86
3. White Silesian	21.45	18.15	25.94	21.85
4. Red Skinned	21.55	20.60	22.38	21.51
5. Royal Giant	14.95	19.29	29.63	21.29
6. Green Top White	18.35	18.91	26.56	21.27
7. White French	17.35	14.39	29.06	20.27
8. Lane's Improved	20.45	16.28	22.75	19.83
9. Champion	19.25	17.18	22.38	19.60
10. Carter's Nursery	13.35	14.93	29.38	19.22
11. Giant Red Half Sugar	14.50	17.67	25.38	19.18
12. Giant White Half Sugar	14.05	17.22	25.38	18.88
13. Kleinwanzlebener	14.38	16.81	23.06	18.08
14. French Yellow	13.15	15.14	23.19	17.16
15. Queen of the Danes	11.65	12.63	26.00	16.76
16. Pitzscheke's Elite	14.85	14.61	20.63	16.70
17. Imperial Grey Top	11.85	15.87	21.81	16.51
18. Improved Imperial	14.00	14.22	21.31	16.51
19. Jersey	13.70	14.63	20.69	16.34
20. Mangel Sugar Beet	.....	13.01	20.50	16.76
21. Vilmorin's French Sugar	.....	13.22	19.44	16.33
22. Ideal (Keirche)	.....	.....	30.13	30.13
23. Tankard Cream	.....	.....	28.56	28.56
24. Kleinwanzlebener (Mette)	.....	.....	21.50	21.50
25. Jaensch's Victrix	.....	.....	21.44	21.44
26. Rubensamen (Rimpan)	.....	.....	21.06	21.06
27. Dieckman No. 3	.....	.....	20.44	20.44
28. C. Vorstadt Beet Seed	.....	.....	20.44	20.44
29. Dieckman No. 1	.....	.....	19.63	19.63
30. Dieckman No. 2	.....	.....	19.13	19.13

It will be seen that the Kleinwanzlebener, which is the variety principally used for the production of beets for the four factories now manufacturing sugar in Ontario, yielded 14.4 tons per acre in 1900; 16.8 tons per acre in 1901, and 23.1 tons per acre in 1902, making an average of a little over 18 tons per acre for the three years. Vareities such as the Red Top and the New Danish Improved, which produce heavy crops per acre, contain a much less percentage of sugar, and are not suitable for factory purposes. The last nine varieties on the list were all grown from fresh seed, nearly all of which was imported directly from Germany in the spring of the present year. They were obtained from different sugar beet breeders in Germany, who have made a specialty of selecting beets for many years in order to obtain a high percentage of sugar. For the results of the chemical analysis of these beets, the reader is referred to the report of the Chemical department, written by Prof. Harcourt in a previous portion of this volume.

Eight varieties of sugar beets have now been grown in the experimental department for nine years in succession. The following are the average yields in tons per acre for the nine years : Red Top, 19.7; White Silesian. 19.3; Lane's Improved, 19.3; Champion, 18.6; White French, 17.5; Red Skinned, 16.4; Kleinwanzlebener, 16.3; and Improved Imperial, 14.3. Three other varieties, which have been grown for seven years in succession, have produced the following average yields per acre: New Danish Improved, 21 tons; Jersey, 18.5 tons; and French Yellow, 17.8 tons.

Planting Sugar Beets at Different Distances Between the Drills.

An interesting experiment was conducted on our trial grounds in 1902 for the first time by planting sugar beets in rows nine different distances apart. The variety of sugar beets known as the Kleinwanzlebener was used. There were seven rows in each plot, each row being four rods in length. The experiment was conducted in duplicate. The following table gives the average results of the duplicate tests :

No.	Distances.	Average of two tests.	
		Average weight per root.	Yield of roots per acre.
		lbs.	tons.
1	12 inches apart	.72	26.02
2	14 " "	.78	23.92
3	16 " "	.82	23.41
4	18 " "	.93	22.60
5	20 " "	1.02	22.46
6	22 " "	1.05	21.52
7	24 " "	1.10	20.38
8	26 " "	1.14	20.00
9	28 " "	1.18	18.82

From the results here presented, it will be seen that, as the distance between the rows increased, there was an increase in the average size of the roots and a decrease in the yield of roots per acre. The roots which were grown in rows 18 inches apart, which is the usual distance to grow sugar beets for sugar production, yielded 22.6 tons per acre in comparison with 20.4 tons from rows 28 inches apart, and 18.8 tons from rows 28 inches apart. Samples from the various parts of this experiment were taken by Prof. Harcourt for analysis from the standpoint of sugar production. For the results of these analyses, the reader is referred to the report of the Chemical department in this volume.

Varieties of Field Roots.

Extensive experiments have been conducted in past years in testing different varieties of the various classes of field roots. The results of these experiments have appeared in the College reports from time to time. The following are among the leading varieties in each class of roots : Swede Turnips,—Sutton's Magnum Bonum, Improved Purple Top Yellow, Buckbee's Giant, Hartley's Bronze Top, and Kangaroo; Fall Turnips,—Red Top, White Globe, Cow Horn, and Jersey Navet; Mangels,—Yellow Leviathan, Sutton's Mammoth Long Red, Evans' Improved Mammoth Sawlog, and Steele's Long Red Selected; Carrots,—Mastadon White Intermediate, Mammoth Intermediate, Smooth White, and Pearce's Improved Half Long White; Parsnips,—New Ideal, Hollow Crown, and Improved Half Long.

Selection of Seed of Field Roots.

A considerable amount of attention has been devoted to experiments in different selections of root seed within the past few years. For this experiment, good commercial seed of the best varieties was obtained in the spring of each year. The seed was then graded, first, by the use of sieves, and then by hand picking, until distinct selections were secured. Nothing but sound seed, however, was used in each instance. The experiment included sugar beets, mangels, swede turnips, fall turnips, and carrots, and was repeated for three, four, and five years in succession. But few people even imagine the great importance there is in sowing seed of the best quality. A large, well-developed seed will almost always produce a much better plant than a smaller seed of the same variety. The results of these experiments show the great importance of using special care in the selection of the seed of our common field roots.

Crops.	Number of years of Experiment.	Average yields of roots per acre.		
		Large seed.	Medium sized seed.	Small sized seed.
		tons.	tons.	tons.
Sugar Beets	4	23.67	22.52	15.69
Mangels	5	33.19	29.62	21.52
Swede Turnips	4	13.97	12.39	5.66
Fall Turnips	3	22.79	19.45	11.97
Carrots	5	24.47	22.23	16.23
Average		23.62	21.24	14.21

Planting Whole and Broken Seed of Mangels and Sugar Beets.

Enquiries were made in the spring of 1902 as to the practicability and value of breaking the husks of both mangel and sugar beet seed before sowing. These enquiries suggested the advisability of our conducting some experiments along this line at once. We, therefore, conducted an experiment by taking both mangel and sugar beet seed and breaking the husk in various ways. It was a very difficult matter, however, to remove the husk without injuring the seed. Although we were very careful in the experiment, we were unable to make a satisfactory separation of the husk from the seed; and in every test the whole seed produced a greater yield of roots than a similar quantity of broken seed.

Sprinkling Turnip Seed With Coal Oil to Prevent Injury by the Turnip Fly.

By request, an experiment was conducted in 1902 by thoroughly mixing a large teaspoonful of coal oil with a pound of turnip seed just before sowing. The treatment caused no injury whatever to the seed, and appeared to secure a slightly better stand of plants, which gave a small increase in yield of roots over the untreated seed. This experiment will likely be repeated in future years.

Planting Seed of Field Roots at Different Depths.

In 1902, the seed of both sugar beets and carrots was planted at different depths in the soil. The experiment was conducted in duplicate with each variety. The following gives the average number of tons produced by each class of roots at each of the various depths to which the seeds were planted : 1-2 inch deep,—Sugar Beets 18.8 tons, Carrots 12.7 tons ; 1 inch deep,—Sugar Beets, 19.8 tons, Carrots, 12.4 tons ; 1 1-2 inches deep,—Sugar Beets, 17.1 tons, Carrots, 7.6 tons; 2 inches deep,—Sugar Beets, 18.3 tons; Carrots, 5.9 tons; 3 inches deep,—Sugar Beets, 18.3 tons, Carrots, 5.9 tons ; 3 inches deep,—Sugar Beets, 13.8 tons, Carrots, 3.1 tons; 4 inches deep,—Sugar beets, 7.6 tons, Carrots, 1.5 tons. Similar experiments were conducted with sugar beets for three years, and with carrots two years previous to 1902. The average results show that the seed which was planted only 1-2 inch deep gave the best results, with both classes of roots.

Flat and Ridged Cultivation for Sugar Beets.

Four plots were sown with sugar beet seed, two of them being left on the level and the other two being ridged before the seeding took place. The object was to ascertain whether or not as good results could be obtained from growing sugar beets on land which remained level as from land which was made into ridges by means of a double mould-board plow. The variety of sugar beet used for this test was the Kleinwanzlebener, which is the one principally grown in Ontario for the production of sugar. The rows were made 21 inches apart, and the plants were thinned to 7 inches apart in the rows. The experiment was conducted in duplicate, and the average of the two tests shows that 20.6 tons of roots were obtained from the level cultivation, and 19.8 tons from the ridged cultivation. It is, therefore, seen that the results from growing sugar beets in 1902 are best from level cultivation, so far as yield per acre is concerned. These results are very similar in this respect to the results of experiments conducted previously in growing other kinds of roots under the two methods of cultivation here described.

Fertilizers with Swede Turnips.

For four years in succession, an experiment was conducted in duplicate by applying fertilizers to the land on which swede turnips were grown. The fertilizers and the quantities used per acre of each were as follows : Nitrate of Soda, 160 pounds; Muriate of Potash, 160 pounds; Superphosphate, 320 pounds; and mixed fertilizer, 213 1-3 pounds. The mixed fertilizer was made by using one-third the quantity of each of the fertilizers used on the other plots. The muriate of potash and the superphosphate were applied at the time of seeding, but the nitrate of soda was not sown until the turnips were about two inches in height. The cost of the fertilizers, as used in this experiment, would amount to about $4.00 per acre. The following results give the average yield in tons per acre from the fertilizers applied in four separate years : Mixture, 16.7 tons; Superphosphate, 15.9 tons ; Nitrate of Soda, 15.3 tons; Muriate of Potash, 14.3 tons; and the unfertilized land, under similar conditions, gave 12.8 tons. It will, therefore, be seen that the mixed fertilizer increased the yield of turnips about 4 tons per acre at a cost of about $1.00 per ton for the fertilizer used.

Experiments with Corn for the Production of Fodder or Silage.

Owing to the very cool weather and the unusually large amount of rainfall during the past summer, the results of the experiments in corn growing are in some respects different from those of previous years. The crops were very much later than usual in reaching maturity.

Varieties. One hundred and thirty-five varieties of corn were grown in the experimental department in 1902. Owing to the peculiar weather conditions, only about twenty of these varieties reached maturity in time for cutting in the autumn. The greatest total yields in 1902 were produced by the New Delaware Dent, 24 tons; and Pedrick Perfected Golden Beauty, 23.8 tons per acre. Those producing the largest yield of husked ears per acre in the past year were the Golden Leneway Dent, 4.3 tons; Snow White Dent, 4.3 tons; and Black Mexican Sweet Corn, 4.2 tons per acre.

Of all the varieties which have been grown for several years in succession, we find that the Mammoth Cuban and the Mastadon Dent are varieties which give excellent results on the warm soils of Southern Ontario, where many varieties of corn can be grown successfully; that the Wisconsin Earliest White Dent gives a good yield of total crop per acre, which is of excellent quality. This variety has produced the largest yield of ears per acre among all the varieties grown for six years in succession, and is well suited to the central part of Ontario, where the frosts are not too severe; and the three flint varieties,—Salzer's North Dakota, Compton's Early, and King Phillip,—and the one Dent variety, North Star Yellow Dent, have given good results and are well suited for the central and southern part of Ontario.

Different Depths of Planting. In an experiment which has been conducted for four years in planting corn, 1-2", 1", 1 1-2", 2", 3", and 4" in depth, the greatest average yields were obtained from planting 3 inches deep in 1899, and 2 inches deep in each of the years 1900, 1901, and 1902. The following gives the average results in yield of corn per acre produced in the average of four years' tests from planting at six different depths, starting with the largest and finishing with the lowest yields: 2 inches, 13.2 tons; 1 1-2 inches and 3 inches, each, 11.8 tons; 1 inch, 11.7 tons; 1-2 inch, 10.6 tons; and 4 inches, 9.8 tons.

Methods of Cultivation. For the first time, an experiment was conducted in 1902 by cultivating corn in the four different methods here described. The North Star Yellow Dent variety of corn was used in the experiment, and the experiment was conducted in duplicate. Each test consisted of four plots. The average results of the two tests made are as follows: (1) Deep cultivation at first, gradually getting shallower as the season advanced, 23.9 tons per acre; (2) Shallow cultivation throughout the season, 23.6 tons per acre; (3) Deep cultivation throughout the season, 23.3 tons per acre; and (4) Shallow cultivation at first, gradually getting deeper as season advanced, 22.3 tons per acre. From these results it will be seen that in a season such as we had in 1902, corn which was cultivated deeply immediately after it was planted, and in which the cultivation was shallower as the season advanced, produced the greatest yield, while that which was cultivated shallow at first and deeper as the season passed by, produced the lowest yield. This experiment will likely be repeated in future years.

Varieties of Millet for Green Fodder.

Thirteen varieties of millet have been grown for the production of fodder for eight years. There has been a marked difference in the productive-

ness of the different varieties under experiment; as, for instance, the average yield of green crop per acre for eight years is 4.9 tons for the Red French and 6.1 tons for the White French varieties; while that for the Golden Wonder, Holy Terror, Gold Mine, Japanese Panicle, Japanese Barnyard, and Magic varieties, yielded 11.6, 11.4, 10.4, 10.3, and 10.3 tons per acre, respectively. The Japanese Common millet, which has been grown for seven years, has produced an average of 11.5 tons of green crop per acre. The three heaviest yields in 1902 were the following : Japanese Common, 10.9 tons per acre, and Japanese Barnyard and Holy Terror Gold Mine, each 9.7 tons per acre.

Varieties of Rape.

The Dwarf Essex and the Dwarf Victoria varieties of rape have each been tested under similar conditions in the experimental grounds for eight years. The average results show that the Dwarf Essex variety has produced 23.4 tons, and the Dwarf Victoria variety, 21.8 tons of green crop per acre. The Buckbee's Wonderful Bonanza rape was grown here for the first time in 1902, and it gave satisfactory results.

Varieties of Sorghum for Fodder.

Sixteen varieties of sorghum have been tested in the experimental grounds for three years. These included different varieties of sugar cane, broom corn, Kaffir corn, etc. As there is much interest being taken in the cultivation of sorghum as a stock food in some parts of Ontario, the average results of each of the sixteen varieties are here presented :

Varieties.	Average for 3 years.		
	Per cent. of leaf to stem.	Yield of heads per acre.	Yield of green fodder per acre.
		Lbs.	Tons.
1. Early Minnesota Sugar Cane	16	1,353	17.3
2. Orange Sugar Cane	34	273	16.8
3. Fodder Cane	25	1,553	14.4
4. Early Amber Sugar Cane	19	987	13.7
5. Kansas Orange Sugar Cane	32	240	13.6
6. Black Rice Corn	41	687	13.3
7. White Kaffir Corn	36	1,373	12.9
8. Red Kaffir Corn	44	563	11.2
9. California Golden Broom Corn	26	2,387	9.9
10. Yellow Millo Maize	34	860	8.8
11. Improved Evergreen Broom Corn	23	2,073	8.5
12. Early Japanese Broom Corn	22	2,247	8.5
13. Brown Dhoura Corn	38	1,667	7.6
14. Dwarf Broom Corn	35	1,633	7.1
15. White Millo Maize	43	60	7.1
16. Jerusalem Corn	38	847	5.9

The greatest yields in 1902 were produced by the Early Minnesota Sugar Cane, 19.1 tons; Fodder Cane, 16.7 tons; Early Amber Sugar Cane, 16.6 tons; and Rennie's Improved Amber Cane, 13.7 tons of green crop per acre.

Some Leguminous Crops for Green Fodder.

For two years in succession, experiments have been conducted with sixteen varieties of leguminous crops for the production of green fodder. Some of these varieties have been tested for a very much longer period of time; but, for the sake of comparison, the results here presented are for the two years in which all of the varieties were grown under uniform conditions:

Varieties.	Average for 2 years.	
	Length of plants.	Tons of green crop per acre.
	Ins.	Tons.
1. Hairy Vetches	33	13.90
2. Medium Green Soy Beans	29	11.68
3. Horse Beans	36	10.35
4. Common Vetches	.....	9.70
5. Grass Peas	39	8.55
6. Early Yellow Soy Beans	25	8.15
7. Wonderful Cow Peas	19	8.04
8. Prussian Blue Peas	48	7.93
9. Extra Early Blackeye Cow Peas	18	7.90
10. Taylor Cow Peas	15	7.60
11. New Era Cow Peas	17	7.03
12. American Coffee Berry	22	6.68
13. Whip-poor-will Cow Peas	16	6.53
14. Warren's Extra Early Cow Peas	17	5.50
15. Velvet Beans	14	2.97
16. Extra Early Dwarf Soy Beans	20	2.53

It will be seen that the Hairy Vetches have given an average of 4.2 tons per acre more than the Common Vetches in the average of two years' experiments. Further, these varieties have been tested one with the other for the past six years, and the average results are: Hairy vetches, 10.5, and the Common Vetches, 6 tons of green crop per acre. The Medium Green Soy Beans, which stand second on the list, are an exceptionally fine variety, and we believe will be a valuable crop to grow for fodder, either for feeding in the autumn or for mixing with corn for the silo in order to increase the quality of the silage. The Horse Beans, which stand third on the list, have done much better than usual during the last two years. The season of 1902 was specially well adapted to the growth of Horse Beans. In most seaons, this crop has resulted in a total failure. Grass Peas gave much better results in 1902 for green fodder than for the production of grain. Owing to the frequent rains, the crop continued green for a long time, and many who were growing Grass Peas with the object of securing a grain crop, were compelled to cut and dry them for hay. The Early Yellow Soy Beans are not so good a kind for the production of green fodder as the Medium Green variety. The first named variety, however, is earlier in maturing, and in most sections of Ontario will likely be a better variety than the Medium Green for the production of grain. Most of the varieties of Cow Peas come towards the end of the list in comparative yields of green fodder.

Annual Crop of Pasture.

As a result of many enquiries about the value of spring crops for the production of pasture, an experiment was started in the spring of 1900, to

find out which annual crops were likely to give the best results when used for pasture. For this purpose we have tested eighteen crops for three years in succession. In each of the three years the crops were sown in three separate sets, there being eighteen plots in each set, thus making in all a total of fifty-four plots each season. All of the plots were sown on the same day, and under similar conditions each year. The main object of the experiment was to find out the relative value of the different crops for pasture, both early in the season and throughout the summer. The seed was all sown on the 5th of May in 1900, on the 6th of May in 1901, and on the 9th of May in 1902. The three sets were handled each year as follows :

Set 1. The crops on all the plots in Set 1 were cut at the end of six, nine, twelve, fifteen, and eighteen weeks after the seed was sown, thus making five cuttings for each crop. Each cutting was weighed in the green state, and also after it was dried in the form of hay.

Set 2. Each crop was cut when it was thought to contain the greatest bulk of the best quality of green fodder. In order to ascertain the after-growth, another cutting was also made from each plot later in the season.

Set 3. A hurdle fence was placed around the set of eighteen plots, and cattle were turned on the plots daily until the pasture was all eaten. The first pasturing took place in the latter part of June and the early part of July. Careful notes were taken of the amount eaten of each crop each day. After the crops were pastured the first time, they were allowed to remain undisturbed until the autumn, when the cattle were again turned on, and the second growth was eaten off.

The table here presented gives the average results for the three years in yield of green crop per acre produced by each variety on the five dates of cutting, as determined in Set 1. It also gives the total amount of green material produced from the five cuttings of each crop:

Crops.	Tons of green crop per acre, at each cutting—Average of three years.					Total number of tons per acre in five cuttings.
	1st cutting 6 weeks after seeding.	2nd cutting, 9 weeks after seeding.	3rd cutting, 12 weeks after seeding.	4th cutting 15 weeks after seeding.	5th cutting, 18 weeks after seeding.	
	tons.	tons.	tons.	tons.	tons.	tons.
1. Hairy Vetches	.99	3.68	1.63	1.57	.79	8.66
3. Crimson Clover	.01	2.32	2.10	1.02	2.03	7.47
3. Siberian Oats	3.35	1.78	1.59	.33	.27	7.32
4. Early Amber Sugar Cane	.08	1.70	3.15	1.03	1.00	6.96
5. Common Red Clover	.00	1.55	2.34	1.45	1.60	6.94
6. Common Vetches	1.21	2.29	1.38	.64	.80	6.32
7. Spring Rye	5.08	.65	.40	.00	.00	6.13
8. Dwarf Essex Rape	.40	2.77	1.45	.62	.73	5.97
9. Hungarian Grass	1.09	1.98	1.60	.83	.33	5.83
10. Mandscheuri Barley	3.48	1.02	.67	.08	.15	5.40
11. Grass Peas	1.49	2.22	.92	.22	.08	4.93
12. Kaffir Corn	.01	1.88	1.59	.71	.69	4.88
13. Compton's Early Corn	.40	2.38	1.23	.49	.01	4.51
14. Wild Goose Spring Wheat	2.17	.93	1.12	.11	.07	4.40
15. Prussian Blue Peas	2.14	1.19	.28	.00	.00	3.61
16. Early Yellow Soy Beans	.53	1.23	.58	.34	.28	2.96
17. Cow Peas	.12	1.80	.27	.21	.07	2.47

The results of these experiments up to the present time seem to show the advantage of growing a mixture of annual crops, rather than growing the crops separately for pasture. The results indicate that the following combinations should prove serviceable for the production of pasture of good

quality throughout the season, viz., (1) Oats, Hairy Vetches, and Early Amber Sugar Cane; (2) Spring Rye, Hairy Vetches, and Hungarian Grass; and (3) Barley, Crimson Clover, and Early Amber Sugar Cane.

Grasses and Clovers.

Some experimental work has been done at the College with grasses and clovers each year since the Experimental department was started in 1876. Most of the results of these experiments have been reported from time to time. During the past few years, we have begun a number of interesting and important experiments which are now in progress, and which will be reported more fully in future publications. Only a few references to some of them are made in this report.

Varieties of Grasses and Clovers. Quite extensive experiments have been conducted with different varieties of grasses and clovers for green fodder, for hay, for pasture, and for seed; but it is very difficult to give a summary of the results, since the different varieties vary so much in their characteristics, as, for instance, the Crimson Clover is an annual, the Common Clover is a biennial, and the Lucerne or Alfalfa is a perennial. Short reports were given of this work in the College Report for 1901; and as most of the experiments were continued for several years, we hope to be able to present the results in a more detailed form on some future occasion.

Mixtures of Grasses and Clovers for Hay. An experiment was conducted with twenty-one mixtures of grasses and clovers from 1897 to 1899, and was repeated from 1898 to 1900. As the average results of these experiments, we find that Tall Oat Grass and Lucerne gave 3.2 tons of hay per acre; Tall Oat Grass, Orchard Grass, Mammoth Red Clover, and Lucerne gave 3.1 tons, and the Timothy and Lucerne 3.1 tons. Nearly all of the others gave a yield of between 2 and 3 tons per acre, except some of the mixtures containing Orchard Grass, which gave slightly below 2 tons per acre. The Orchard Grass was considerably killed during the second winter. It will be observed that the Lucerne was one of the varieties in each of the three mixtures which gave the largest yields of hay per acre. This experiment is now being conducted for the third time. The seeds were sown with a grain crop in the spring of 1901, and each plot of hay was carefully harvested and weighed this season. Owing, no doubt, to the peculiar weather conditions of the past summer, the results are somewhat different from those of previous experiments. The greatest yields in 1902 were produced by Timothy with Mammoth Red Clover; Tall Fescue with Mammoth Red Clover; Tall Oat Grass with Mammoth red Clover; and Orchard Grass with Mammoth Red Clover. It will be seen that the results of those mixtures in which Mammoth Red Clover was included were very high this season. These plots will all be cropped again in 1903.

Mixture of Grasses and Clovers for Permanent Pasture. As the result of several years' experiments, the following mixtures, with amounts of seed used of each variety, has given the best results as a permanent crop of grasses and clovers: Orchard Grass, 4 lbs.; Meadow Fescue, 4 lbs.; Tall Oat, 3 lbs.; Timothy, 2 lbs.; Meadow Foxtail, 2 lbs.; Lucerne, 5 lbs.; Alsike Clover, 2 lbs.; White Clover, 1 lb.; and Trefoil, 1 lb,—making a total of 24 pounds of the mixture of grass and clover seed per acre.

Grain Crops Grown on Grass Sod and on Clover Sod. In 1899, in 1900, and in 1902, experiments were conducted by sowing grain on land which

had produced grass in one case and clover in the other. Both the grass and the clover crops were removed from the land, the stubble was plowed, and the grains were sown in order to ascertain the comparative value of the different sods for the production of grain. The grain sown for these experiments was a mixture of oats and barley in 1899, winter wheat in 1900,and barley in 1902. The average results of the experiments in number of pounds of grain per acre are as follows: Mixture of oats and barley from grass sod,1,078 and from clover sod, 2,256; of winter wheat from grass sod, 2,300, and from clover sod, 3,194; and of barley from grass sod, 1,022, and from clover sod, 1,451. Taking the average of the three years, we find that we obtained 1,467 pounds of grain per acre from the grass sod, and 2,300 pounds of grain per acre from the clover sod, thus making a difference of 833 pounds of grain per acre in favor of the clover sod.

ACKNOWLEDGMENTS.

I wish to acknowledge the valuable services rendered during the past year by my foreman, Mr. A. E. Whiteside, in looking after the details of work of the department; by my assistant, Mr. W. J. Squirrell, in the office work; by Mr. J. Buchanan, B.S.A., in the work of plant breeding, and by Mr. L. S. Klinck, a senior student, in assisting with the farmers' excursions which came to the College in the month of June.

CONCLUSION.

I wish to thank both yourself and the Minister of Agriculture for the kindly support given me in the work of the Experimental Department during the past year. The department is now taxed to its utmost, and I ask for more help and for more money in order to make the experimental work in field agriculture of greater value to the Province. Acording to the reports of the Bureau of Industries, the farm crops which are now produced in Ontario have a market value of upwards of one hundred million dollars a year. I, therefore, feel justified in asking for good substantial support in the work of this important department.

Respectfully submitted,

C. A. ZAVITZ.

PART XIV.

THE MANAGER OF THE POULTRY DEPARTMENT.

To the President of the Ontario Agricultural College :

Sir,—I have the honor of presenting herewith the report of the Poultry Department for the year 1902.

A larger amount of experimental work than usual has been carried on this year, especially with the hatching of eggs during the months of January, and the fattening of chickens; but this work needs to be carried further before definite and reliable conclusions can be drawn.

Farmers in general are taking a more active interest in their poultry, as is manifested in the increased correspondence, and the special interest taken during their visits here from time to time.

The prices of poultry and eggs have been high this year; but the increase has not been any more than enough to balance the advance in the prices of grains. In fact, this has not been so good a year for the small poultry farmer as some other years, but it has been an excellent year for the farmer who keeps but a small flock, which pick up a large portion of their living in food that would otherwise go to waste.

From a financial standpoint, the past year has not been a very successful one in this department, owing largely to the fact that we had a number of unprofitable experiments, especially in rearing early chickens, and the fattening of fowls on an "all cooked" grain ration.

There was a good attendance at the Short Course in Poultry Raising during January. Some twenty-nine students took advantage of this course. This number is fully as many as we can accommodate, and give anything like the practical work that should be given. The large majority of the students expressed themselves as being well satisfied with the course, and they have had better success during the past season than heretofore.

Special lectures in the Short Course were given by L. H. Baldwin, Deer Park, Ont.; W. J. Bell, Angus, Ont.; and Newton Cosh, London, Ont.

The usual number of lectures were given to the regular College students, and to the Farm Dairy Class.

During the month of May, I visited a number of the leading poultry farmers in the States of New York, Massachusetts, and Rhode Island. I also visited the Experiment Station and Agricultural College at Kingston, Rhode Island.

The farmers in the sections visited raise more poultry and eggs than our farmers, and state that they find it much more profitable than any other branch of farming. It must be remembered, however, that they are very convenient to such large markets as Boston and New York, where very high prices are paid for gilt-edged products.

While visiting the poultry farms at Groton, N.Y., I was very much impressed with the large number of farmers who were making a specialty of producing eggs only, especially white eggs, to be sold in New York City.

Practically every farmer, large and small, kept hens to lay only, and the one breed was Leghorns. They made no attempt to produce market chickens. As might be expected, we found incubators and brooders in general use.

In the part of Massachusetts that I visited, I found the poultrymen trying to produce brown eggs for the Boston market, and as many yellow-skinned broiler and roaster chickens as they could raise. In this locality, also, egg production was of importance, but raising chickens for the market seemed to be looked on with more favor. Here, as might be expected, Plymouth rocks and Wyandottes were much in evidence, and the Leghorn was looked upon as a fowl of no special value. Some farmers used a large number of incubators; others used both hens and machines; and a few used hens only.

I was much impressed with the Rhode Island poultry farmers. In the district through which I travelled, in the vicinity of Little Compton, nearly every farmer was a chicken man, kept from 500 to 1,500 laying hens, and raised from 1,000 to perhaps 8,000 chickens. Practically only one breed was seen, and that one was Rhode Island Reds. A few flocks of Brahmas were seen, as well as odd flocks of Rocks and Wyandottes. Here the farmers practically raised and hatched all their chickens with hens. The breed being a general purpose one, and the hatching being done in the natural season (the months of April, May and June), the incubator was not a necessity, and the farmers were well satisfied with the natural method; and well they should be if they all got as good hatches as the one I saw at Mr. Wm. Sissons's, where 70 hens were taken off with 700 chickens. The hens in this portion of the State are practically all housed on the colony plan, each house accommodating about 40 birds. There are seven or eight houses in a four acre field. A horse and a cart go the rounds daily for feeding, watering, and collecting the eggs. I was particularly interested in seeing whole grain in front of the hens continually, and the fine health and vigor of the flocks. The fowls here have practically free range the year round, which does away with many objections that we should find here, to keeping feed in front of birds continually.

The Rhode Island farmers raise geese extensively, some having from 300 to 500 goslings.

Corn is fed much more freely than it is in Ontario; in fact, as far as I could learn, it was used fully as much as wheat. All kinds of fowls were fed corn.

Hatching Eggs in January.

During the month of January, we set 1,546 eggs in the incubators. It has always been a problem to get well-fertilized eggs at this season of the year, and what eggs are fertilized have, as a general rule, very weak germs. The machines were filled primarily to give the Poultry School students practice in handling incubators; and secondly, to determine what results might be obtained from eggs at this season of the year.

The eggs were purchased in New York State, Amherst, N.S., London, Ont., Toronto, Ont., and Guelph, Ont., and some were laid by our own hens. The prices paid varied, according to the locality, from $4 per 100 to $10 per 100. As far as results were concerned, there was little difference where the eggs came from—very few chickens were hatched from any of them. From the 1,546 collected and set in January, 226, or a little of 14.6 per cent., of rather weakly chickens were hatched. It was practically im-

possible to raise these chickens, and very few reached broiler size. As to the cause of the failure, I cannot speak; but I am of the opinion that the steady cold weather influenced the birds, making them rather inactive; and some of the eggs may have been chilled before reaching us. The weather being cold, we did not ventilate the incubator room so much as we would like; so there is a possibility that the chicks did not receive sufficient oxygen, or pure air, during the process of incubation.

Later Hatching.

We used both the incubators and the hens for hatching during April and May. The incubators hatched about as well as the hens; but in some cases where hens were set upon specially selected eggs from individual hens which had been mated for special purposes, we got rather better results than we did from the average sitting.

There is still much trouble with chickens dying in the shell during the period of incubation, but more particularly during the seventeenth and eighteenth days. This is attributed to many causes, one of which is a lack of evaporation of the egg contents, or too much evaporation. We weighed the eggs sent under several hens this season, and noted the loss in weight; and we also weighed the eggs set in some of the incubators. We have not yet collected sufficient data to warrant publication; but in one or two cases where the evaporation was practically the same under the hens and in the incubator, there were widely different results. We also found the indivdual hens varying greatly in the loss in weight of the eggs set; and yet they hatched practically the same percentage. We are greatly in need of experimental work along these lines; and I am asking for a special appropriation for that purpose.

The average hatch of both was about 50 per cent. Of course, some were much better; and the eggs from some pens were much better fertilized than from others. We had two pens of different breeds from which, for a time, we failed to hatch a chick. This was no doubt due to the sterility of the cock-bird, as in each case when the male was removed and a new one placed in the pen, the eggs hatched fairly well.

General Treatment of Breeding Stock.

During the past winter, our system of feeding was much the same as in previous years. Some whole grain was fed in the straw or litter early in the morning; roots were fed at noon; and a mash, or soft food, was given at night, with a little whole grain immediately afterwards. This method of feeding gave very good results.

We have aired our houses much more freely than in previous years, not a day passing but the doors have been opened for a time. Of course, in cold weather, the doors are closed much sooner than in mild weather. We open the house early in the morning and give it a good airing, and get the birds to work, which keeps them warm; and the fresh air does them good. We do not object to the water freezing a little. Some days we find it necessary to renew the water two or three times. It will not do to have the house so cold that the hens' combs will freeze, else egg production will cease. If there is danger of the male's comb freezing, he may be put into a barrel at night and covered with a sack. This treatment generally prevents the comb from being frosted. Our birds are much better in health when they are given plenty of fresh air, and the egg production is better than when the houses are closed and stuffy.

The hens moulted very early last season, which made the summer egg production much short of what it usually is; but it should result in better returns this winter.

Layers.

We are working to produce an especially heavy laying strain of Barred Plymouth Rocks, and the other varieties we are breeding are being worked more or less along the same line. The particularly good layers are mated together, and their progeny kept for the next season's breeding. Our object is to get a good utility fowl, and one that will at the same time be no disgrace in a show pen. The work has been slow and rather disappointing at times, but it is gratifying to know that some progress is being made.

The Plymouth Rocks, Wyandottes, Orpingtons, and the Langshans laid best during the winter; and the Leghorns, Andalusians, and Minorcas did best in the summer.

Buff Orpingtons.

The Orpington is being boomed in Ontario as the ideal farmer's fowl. Its legs and skin are naturally white; and it is claimed by its supporters to have all the good qualities of the popular Plymouth Rocks and Wyandottes. Our experience with them during the past season, is that they are good winter layers, good sitters, and good mothers, and the chickens grow well and make good market birds.

To those who are breeding Orpingtons, I would say: Select with great care; do not try to sell every chicken for a fancy price simply because its legs are white. Preserve the short, cobby English type, and avoid the long-legged, long-backed, heavy weight sort that is in favor in some parts of America.

The desire of some Orpington strains to sit persistently during warm weather should be bred out.

Plymouth Rocks and Wyandottes.

The Plymouth Rocks and Wyandottes are well established in many parts of Ontario, and are giving general satisfaction. If the breeders of these varieties keep to the proper type, they are sure to remain popular. Newcomers may be as good, but they must be better in many ways in order to supplant the old-time favorites.

Ducks.

This sason, we set a large number of duck eggs in the incubators, with very poor results. I am of opinion that one of the causes of the failure to get good hatches was due to a lack of sufficient pure air in the hatching chamber.

Eggs set under hens hatched moderately well.

We are holding a much larger number of ducks over for breeding purposes, with a view to experimenting on the eggs in incubators, and it is hoped that we may be able to report more favorable results next season.

Some thirty ducks were hatched about the first of September. These ducks did especially well, and dressed, December 5th, nearly five and a half pounds each. This is noteworthy, because it is generally conceded that August duck eggs are of little use for incubation. Ducks hatched at this season would mature plenty early enough to suit the Christmas trade, and in many ways would be more profitable than the earlier hatched ones for the Christmas market.

Fattening or Fleshing Chickens.

Our experiments this year cover a longer period of time than they have heretofore. We began in July, and will have a few to feed in January, when the special Short Course in Poultry is on.

Most of the chickens we fattened were sold in Montreal, and the remainder in Toronto. The chickens sold in Montreal were for local use, while the greater part of those sent to Toronto were for export. So far as I can gather from the dealers, they want a plump, five-pound, white-skinned chicken. The larger chickens, weighing from seven to nine pounds each, come into competition with the small turkey, and are therefore not as saleable as the smaller birds. Moreover, the average householder does not care to buy a very large chicken, when a medium-sized bird furnishes all the meat required for the family. The dealers do not, however, complain so much about the size as about the quality. They want birds that are plump, with plenty of meat on the breast, whether they weigh three pounds or seven pounds. During the season, I have had a few shipments of fatted chickens rated as No. 2, owing to the fact that their breast-bones were too high, or too deep, and their legs too long. The dealer in each case said the birds were plenty fat enough, but they lacked breasted meat, or plumpness. It is evident, therefore, that we must be careful in the selection of our breeding stock, and see that they are of a blocky type,—wide and full in the breast, but only moderately deep. The back should be wide and not too long; the legs short and well apart. Our experience during the last few years has been that we have to be quite as careful in the selection of the females as in the selection of the males. Many a fine cock-bird has left badly shaped chickens when mated with the leggy type of females.

As a rule, the birds that are plump when they weight about five pounds never mature into large, heavy-weight birds. They are mature, or fully developed, at nine pounds or under. It appears to me that, to make the greatest possible profit, we need to develop strains (no matter what breeds) that will mature quickly, and be plump when weighing from five to six pounds each.

My experience is, that to produce a ten to twelve pound male, we must have chickens with long bodies and legs, which are generally associated with deep breast bones. Where one has a good market for large chickens, there is no doubt that this class of birds will best serve his purpose; but it is very doubtful if they are as profitable as birds of the blocky, quick maturing type.

Fattening Chickens in July.

Early in July, several groups of chickens were put in crates for fattening. The results are given below :

Lot I. consisted of 12 Barred Rock cockerels, weighing when put into the crate, a total of 37 pounds.

	Lbs. Grain Consumed.	Lbs. Skim-milk Consumed.	Lbs. Gain.	Lbs. of Grain to make 1 lb. Gain.	Average Gain per Bird in 4 weeks.
1st week	17	25	9	1.8	
2nd "	24½	31	5	4.8	
3rd "	20	30	8	2.5	2.1 lbs.
4th "	22	33	4	5.5	

Average amount of grain per pound of gain in 4 weeks, 3.2 lbs.

The birds were sold to a Montreal firm at 15 cents per pound f.o.b. here.

They were rather leggy, had high breast-bones, and would have dressed much better when they had reached a weight of 6 or 7 pounds.

Lot II. consisted of 8 high-grade Leghorns, weighing a total of 18 1-4 pounds.

	Lbs. Grain Consumed.	Lbs. Skim-milk Consumed.	Lbs. Gain.	Lbs. of Grain to make 1 lb. Gain.	Average Gain per Bird in 4 weeks.
1st week	7	10	4	1.8	
2nd "	11	16	1½	7.3	
3rd "	10	15	3	3.33	1.28 lbs.
4th "	7	10	1¾	4.	

Average of grain per pound of gain in 4 weeks, 3.4 lbs.

These chickens realized 13 cents per lb. f.o.b. here.

When dressed they were somewhat plumper than the Rocks, owing to their being mature; but they were rather small.

—	Pounds grain consumed.	Pounds skimmed milk consumed.	Pounds gain per week.	Pounds grain to make 1 lb. gain.	Average gain per bird in 4 weeks.
1st week	24	36	9½	2.6	
2nd week	27	41	9	3.	
3rd week	29	44	14	2.	
4th week	30	45	3	10.	1.77 lbs.

Average amount of grain per pound of gain in 4 weeks, 3.1 lbs.

These chickens dressed fairly well, the breasts being rather plump; but they had an excessive length of legs and neck.

This group was sold at 15 cts. per pound f.o.b. here.

The ration of grain fed three times a day to these lots was made up as follows :

	Parts.		Parts.
Barley meal	2	Finely ground oats	1
Corn meal or chop	2	Animal meal	1
Shorts or middlings	2		

This mixture was used with about one and one-half times its weight of skim-milk.

Feeding all Cooked Food.

We found it impossible to buy finely ground oats during the latter part of August; so we tried cooking rolled oats, barley, and corn-meal. The grains were used in the proportion of 50 per cent. of rolled oats and 25 per cent. each of barley and corn. These foods could not be used in the cramming machine without being first cooked.

Two groups of 12 birds were fed from the trough, one group for two weeks, and the other for only one week, with the following results :

Group I. consisted of 12 grade Plymouth Rock cockerels. They weighed, when placed in the crates, a total of 35 3-4 lbs. During the two weeks, they consumed 103 pounds of cooked food, or equal to about 34 pounds of uncooked grain. They made a gain of five pounds. At the end of the two

weeks the birds were very thin and sickly, their digestion being very bad. One of them died. The others were turned out on a grass run, and two of them died the second day they were out. The remainder are beginning to pick up again.

Another lot of 12 Rock chickens, weighing a total of 62 pounds, which had been fed the previous week on raw food, were given cooked food. During the week they were fed on cooked food they lost in weight, and three of them became so sick that they died. The remaining nine were placed on uncooked food the next week, and made a gain in weight of more than three-quarters of a pound each.

Two hundred chickens were crammed with cooked food. A few of the birds gained slightly, but the majority of them lost in weight. After having been fed in this manner for one week, a few of the best were shipped to a Toronto dealer, who complained about there being no meat on the breast. They sold for 9 cents per pound, and had they been well fatted they would have realized at least 13 cents per pound. The remaining birds were turned loose on a grass run.

The chief difficulty with the cooked food appears to be that it damages the chicken's digestion. Some of the birds that were put out on the grass run after being fed on cooked food, have not recovered yet,—three weeks after being turned out.

Cooked food can, no doubt, be fed to advantage in conjunction with raw food, but an all-cooked ration that is of a forcing nature appears to be entirely unsuitable for fattening fowls.

These chickens were practically a total loss. Those that were turned loose never fully recovered, and were not sold until about the beginning of December. When the food from September first to December first is figured, together with the decline in prices, there is a heavy loss.

Substitutes for Skim-Milk in Feeding.

During October and November, several trials were made with a common mixture of grain, wet with different substances, with a view to getting something that would give as good results as skim-milk. The results of these experiments are given below :

How fed.	Number of birds.	Weight when put up to feed.	Pounds of gain in two weeks.	Pounds of grain consumed.	Pounds of grain to make a pound of gain.	Pounds of milk consumed (estimated).	Cost of grain consumed at $1.40 per hundred.	Cost of milk at 10c. per hundred.	Total cost.	Cost of one pound of gain.	Remarks.
						whey.	cts.			cts.	
*Grain mixture wet with whey.	20	84	18	64	3.55	64	89.6	.....	89.6	4.9	This lot relished the ration and did fairly well.
						whey.					
*Grain mixture wet with whey.	20	67	16	75	4.69	75	105.0	.....	105.	6.56	Did not eat so well as the former group.
						whey.					
Average.....	....	....	17	69 5	4.12	69.5	97.3	....	97.3	5.7	
Grain mixture wet with skim milk.	20	87	20	63	3.15	90	88 2	9.0	97.2	4.86	Relished food.
Grain mixture wet with skim milk.	20	67	21	64	3.20	90	89.6	9.0	98.6	4.7	Relished food.
Average.....	....	....	20.5	63.5	3.18	90	88.9	9 00	97 9	4.77	

SUBSTITUTES FOR SKIM-MILK.—*Concluded.*

How fed.	Number of birds.	Weight when put up to feed.	Pounds of gain in two weeks.	Pounds of grain consumed.		Pounds of grain to make a pound of gain.	Pounds of milk consumed (estimated).	Cost of grain consumed at $1.40 per hundred.	Cost of milk at 10c. per hundred.	Total cost.	Cost of one pound of grain.	Remarks.
				Grain.	Animal meal.				Animal meal @ 2c. lb.			
*Grain mixture with 12 per cent. animal meal added and wet with water.	20	86	19	66	8	3.47	none	92.4	16	108.4	5.7	Relished food only moderately well.
*Grain mixture with 12 per cent. animal meal added and wet with water.	20	82	21	70	8.4	3.33	none	98.0	16.8	114.8	5.47	Relished food and did well.
Average..... ..	....	....	20	68	8.2	3.40	.....	95.2	16.4	111.6	5.58	
Grain mixture wet with skim milk and milk to drink.	20	65	20	49		2.45	100	68.6	10	78.6	3.93	Very careful attention was required to keep these birds in health.
*Grain mixture wet with water.	20	84	9	63		7	none	88.2	.....	88.2	9.8	Did not relish the ration.

* These chickens when dressed were not very white.

Summary:

1. Where a white skin is in demand, the skim-milk ration is the best one to use.

2. The most economical gain is made where the skim-milk is given to drink, in addition to the grain mixture being wet with it; but this mixture is only partially satisfactory, as the chickens require very careful attention to keep them healthy.

3. Where the mixture is wet with skim-milk and water given to drink is apparently the best ration.

4. The grain ration, to which 12 per cent. animal meal has been added and the ration mixed with water, is a very good one, but the flesh has a yellowish tinge.

5. The grain mixture wet with whey has given much better returns than we expected, and it seems to be a fairly good ration.

6. Grain mixture and water is not to be recommended. All these feeds, however, require further testing before definite conclusions can be reached.

My thanks are due to the heads of the other departments, who have rendered kindly assistance in many ways, and also to F. K. Dougherty, the department stenographer.

Respectfully submitted,

W. R. GRAHAM.

PART XV

THE LECTURER ON APICULTURE.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to present herewith my report on the work in the department of Apiculture.

The usual course of eighteen lectures was given in the Fall term to the First Year. The appliances I asked for in last year's Report were bought, and helped me greatly in the lectures, besides interesting the students considerably. By means of a hive on the lawn, I showed them how to handle bees and manipulate the parts of a hive. I teach a simple and up-to-date system of bee-keeping, and if a student takes full notes, and follows them, he can begin in the Spring and manage a limited number of colonies right through the several seasons of the year.

Stimulative Feeding.

Building up colonies in the spring by feeding so as to get an increased surplus in June and July.

Thirteen colonies were chosen; they were of medium strength, and none of them had a queen more than two years old. They were fed from May 1st to May 5th, as follows :

(a) Syrup, consisting of four pounds of granulated sugar to one quart of water was fed in Boardman feeders to three colonies, ten pounds of syrup to each colony.

(b) Ten pounds of this syrup was fed to one colony in a Miller feeder.

(c) Syrup consisting of granulated sugar and water in equal parts by measurement was fed in Boardman feeders to three colonies, ten pounds to each colony.

(d) A seven pound frame of honey was placed in the middle of each of three hives, the caps having been first broken.

(e) Three colonies were not fed at all.

Results in surplus honey which was extracted July 23rd:

(a) Hive No. 1, 76 lbs.; No. 2, 81 lbs.; No. 3, 59 lbs.; average, 72 lbs.

(b) Only one colony was treated in this way, because the result was a foregone conclusion. The Miller feeder reduced the temperature of the brood chamber so much that the colony went back. It produced nothing and became strong only after the honey flow was practically over.

(c) Hive No. 1 had no surplus; No. 2, 43 lbs.; No. 3, 51 lbs; average, 31 lbs.

(d) Hive No. 1, 68 lbs.; No. 2, 71 lbs.; No. 3, 83 lbs.; average, 77 lbs.

(e) Hive No. 1, 57 lbs.; No. 2, 59 lbs.; No. 3, 55 lbs.; average, 56 lbs.

Conclusions :

(1) The temperature of the hive cannot be reduced without harm, as in the case of (b).

(2) To feed syrup that contains a large proportion of water is a positive detriment, presumably because the labor of ripening the syrup is too great a drain on the vitality of the old bees that have come through the winter. This labor would be all the more exhausting in this case, because this

spring (1902) was very wet and cold; and in addition being very backward, there were fewer young bees than are usually to be found. Compare (c) with (a) and (d).

(3) In comparing (a) and (d) with (e), we see that there is an advantage to be gained by stimulative feeding, provided honey (of course, always ripened), or syrup containing the best possible amount of water, is fed. The cost of the syrup is two-thirds that of the honey, while the feeding of the honey in the way specified above is much less labor and there is no annoyance from robbing.

Respecting Quilts Used in Wintering in Chaff Hives.

Two years ago, a number of colonies were wintered outdoors in chaff hives. In packing these hives, we took the cover off of each brood chamber, exposing a quilt on top of the brood frames. We then placed eight inches of leaves on top of the quilts and a water-proof cover over all. The quilts were of enamel cloth. The chaff hives were opened the last of March, and the leaves above the enamel cloth were found to be dry; but when the quilts were lifted up, the brood combs were damp and in places mouldy. However, in four chaff hives the leaves were moist, while the combs were dry and free from mould. In these four cases, the quilts contained holes chewed through them by bees.

The next year, in order to prevent moisture in the brood chambers, wherever the enamel-cloth quilts were not perforated, a small stick, about the size of a pencil, was placed under the back of the quilt, so as to raise it a little off the hive to allow moisture to escape into the leaves. On some hives a quilt made of the plaited wrappings from tea chests was used, without raising it at all from the hive. The chaff hives were examined in March, and the results in every hive were the same, viz., that the moisture from each cluster had escaped from the brood chamber and had been absorbed by the leaves above.

Storing Honey in Paper Sacks.

It was learned in conversation that Americans were storing honey in paper bags. Flour bags called "eighths," of Manilla paper, were tried, but none were found tight enough to hold honey, through not being properly glued. But, aside from that, as long as the bags held honey, the paper did not become saturated or leak in any way, except through holes from the imperfect glueing.

Using Unfinished Sections.

This experiment was tried last year and repeated this year. Unfinished sections were left on a strong hive and other imperfect sections were stored in a hive empty of bees, and into it bees from the hive to be fed were carried on a piece of comb. These bees brought others from their colony. They cleaned out the sections as fast as they were given them, and finished out nicely the sections on their own hive. Robber bees continually tried to get at the sections that were being fed; but the bees that were put in possession kept them out completely. The entrance, however, had to be narrowed to one half of an inch.

Respectfully submitted.

H. R. Rowsome.

PART XVI.

THE LIBRARIAN.

To the President of the Ontario Agricultural College:

Sir,—As College Librarian, I have much pleasure in submitting a brief report for 1902, as we have received much encouragement in our endeavors to build up the Library, assisted, as we have been, by the magnificent donation of the Library Building by the Massey family, of Toronto, and by a larger appropriation from the Legislature, which has enabled us to buy some back sets of periodicals that were greatly needed by several of the Scientific Departments. We trust that the appropriation given last year will be continued, as many back sets of periodicals are still needed.

W. J. Brown, B.S.A., of the Canadian Correspondence College, very kindly presented us with a complete set (6 vols.) of Lyddeker's New Natural History, and in his letter accompanying the gift, expressed the hope that the ex-students of the College would take an interest in the Library, and that the manifestation of this interest would be shown in gifts of books.

We are specially anxious to collect books or sets of periodicals on Canadian Agriculture, and we shall be glad to buy from any one who has books of this class.

Other gifts which we desire to acknowledge are:

Rothamstead Memoirs, Vol. 7.

Report of the Thompson Yates Laboratory.

The Penny Cyclopedia (20 Vols.), given by Rev. Jas. Harris, of Guelph.

Handbook of Insects Injurious to Orchard and Bush Fruits.—Miss E. Ormerod.

We also desire to acknowledge our appreciation of all our Exchanges, especially those of the United States Department of Agriculture, and the various Experiment Stations in America, India, Australia, and Europe.

During the year 1902, six hundred and thirty-nine books were added to the Library, classified as follows:

Agriculture	69	Entomology	28
Horticulture	58	Chemistry	71
Dairying	22	Geology	18
Entomological Reports	2	Veterinary Science	19
Botany	38	Zoology	22
Geology Reports	3	Domestic Science	2
Poultry	8	Hygiene	7
Nature Study	18	Bacteriology	19
Manual Training	6	Science	18
Hygiene Reports	2	English Literature	60
Biology	14	Forestry	7
Science Reports	16	Apiculture	2
Physics	43	Mathematics	1
Agricultural Reports	57	History	8
Horticultural Reports	25		

The number of books bound was 250.

The Library received by purchase or exchange 136 periodicals, most of them bearing on Agriculture.

The total number of bound books on our shelves is 10,027, and between three and four thousand pamphlets.

We have added this year a large steel case, containing 96 compartments for filing current bulletins, etc.; 5 card-case cabinets; a Hammond typewriter for writing our index cards; 45 leather covers for current magazines; and a large quantity of other smaller Library supplies, such as book supports, shelf label holders, pamphlet boxes, index cards, etc.

Respectfully submitted,

F. C. HARRISON.

PART XVII.

THE PHYSICIAN.

To the President of the Ontario Agricultural College:

Sir,—I have the honor of presenting to you my report for the year.

Examination of my records shows that respiratory and digestive disorders were of frequent occurrence, and that tonsilitis, etc., causes a large share of our illness.

In addition to the numerous minor injuries which came under my care, I was called upon to attend a student whose hand was severely lacerated in a turnip-pulper. It was several weeks before he fully recovered the use of the injured member.

I have to report one case of appendicitis. The patient made a good recovery, but on account of his illness gave up his course in the College and returned home.

Mumps and measles invaded the college in January and December respectively, but, thanks to thorough preventive measures, only one case of each disease occurred.

Owing to the outbreak of smallpox in an adjoining township, and in many other parts of the Province, you issued instructions in January for a general vaccination around the College, and accordingly I vaccinated more than one hundred and sixty students, servants, and others connected with the institution.

Among the many improvements being made in the College building, I am glad to note the installation of an electric light system, which will do away with the dangers attending the use of gas, from which we so narrowly escaped a sad experience a year or two ago.

I am glad to report that the general sanitary condition of the College is excellent.

Respectfully yours,

W. O. STEWART,

FINANCIAL STATEMENT, 1902.

I. COLLEGE EXPENDITURE.

(a) College Maintenance.

1. *Salaries and Wages*		$26,953 01
2. *Food:*		
Meat, fish and fowl	5,924 79	
Bread and biscuits	1,192 80	
Groceries, butter and fruit	6,009 27	
3. *Household Expenses:*		
Laundry, soap and cleaning	278 64	
Women servants' wages	2,115 45	
4. *Business Department:*		
Advertising, printing, postage and stationery	1,704 03	
5. *Miscellaneous:*		
Maintenance of chemical laboratory	619 17	
do physical "	356 83	
do biological "	582 24	
do bacteriological laboratory	370 73	
Library, reading room, books, papers and periodicals	2,544 86	
Scholarships	108 40	
Unenumerated	1,426 19	
Short courses in judging	227 14	
*Telephone service, rent and messages	123 94	
School assessment, S. S. No. 7	50 40	
Temporary assistance	79 00	

*Telephone service, etc., transferred to Miscellaneous in Audit Office Report, to balance.

(b) Maintenance and Repairs of Government Buildings.

Furniture and furnishings	1,895 81	
Repairs and alterations	1,452 98	
Fuel	2,910 13	
Light	1,237 42	
Sewage Disposal	450 60	
		$58,613 83

College Revenue.

Fees	4,146 15	
Balance on board account, after deducting $5,924.60 allowances for student labor (See below)	10,252 34	
Supplemental exams	60 00	
Sale of tuberculin	6 50	
Contingencies	9 25	
Refund express charges	6 10	
Sale of old horse	25 00	
Sale of old buggy	15 00	
Analysis of city water	5 00	
*Rent of post office boxes, Sept. 1901—Sept. 1902	32 75	
*Fines and breakages, 1900-1901	65 39	
Chemical laboratory, breakages, 1902	100 00	
Post office box rent, Sept. 1902—Sept. 1903	37 50	
Fines and breakages, 1901-1902	97 20	
Rent of houses	86 00	
		14,944 18
		$43,669 65

*Held over from last year on account of late bursar's death at time when the annual statements were being made out.

Students' Labor to Different Departments.

Jan'y 1st to Dec. 19th, 1902. (*Paid from College Revenue.*)

Farm department	$1,652 39
Experimental department	1,503 13
Horticultural "	1,003 31
Dairy "	291 28
Poultry "	592 46
Mechanical "	322 79
College "	67 24
Engineer's "	103 02
Library	6 80
Bacteriological laboratory	49 51
Physical "	82 01
Chemical "	173 60
Biological "	77 06
Total (as above)	$5,924 60

II. FARM EXPENDITURE.

(a) Farm Proper and Experimental Feeding.

1. *Permanent Improvements*		$509 68	
2. *Maintenance*:			
Wages of foreman and men	$3,657 08		
Live stock, cattle for feeding	4,086 55		
Maintenance of stock	1,748 38		
Seeds	206 40		
Binder twine	60 55		
Repairs, alterations, blacksmithing	513 43		
Furnishings	229 98		
Tools and implements	313 10		
Advertising, printing, postage, and stationery	48 66		
Fuel and light	6 45		
Experimental feeder	376 00		
*Contingencies	265 03		
Purchase of team	450 00		
		11,961 61	
			$12,471 29

Farm Revenue.

Sale of Stock:			
Cattle, (40)	$3,219 25		
Pigs, (132)	1,992 29		
Sheep and lambs, (24)	134 50		
Horse	65 00		
Balance on team	5 00		
		$5,416 04	
Miscellaneous Sales:			
Vetches	5 00		
Potatoes, 400 bags	199 75		
Barley	10 20		
Wool	19 18		
Hides and skins	4 95		
Old iron	4 00		
Milk	88 48		
Ensilage	5 00		
Service of animals	134 00		
		470 56	
			5,886 60
†Net expenditure			$6,584 69

Difference from auditor's report will be found in Miscellaneous account.

†Net expenditure, allowing nothing for supplies to College, feed for dairy stock, keep of horses for College and other departments, etc.

Note.—This statement includes only the cash transactions of the year.

(b) Field Experiments.

Permanent Improvements		$ 864 79	
Experimentalist, salary	$1,500 00		
Foreman, salary	499 99		
Teamsters, wages	578 76		
Other laborers, wages	2,143 31		
Seeds	526 77		
Manure	114 03		
Furnishings, repairs, blacksmithing, etc	267 70		
Printing, postage and stationery	61 11		
Stenographer	300 00		
Assistant experimentalist (part year)	300 00		
Contingencies	150 64		
Horse	140 00		
		6,582 31	
Net expenditure on field experiments			$7,447 10

III. DAIRY DEPARTMENT.

(a) Dairy School.

Wages of Instructors	$1,741 50	
Engineer (3 months)	90 00	
Furnishings, repairs, paintings, etc	516 17	
Dairy appliance	398 79	
Fuel and light	250 00	
Advertising, printing, postage and stationery	125 20	
Lectures in Domestic Science	5 90	
Contingencies	14 61	
Milk for use in School	4,869 60	$8,011 77
Permanent improvements		4 50
		$8,016 27

Revenue.

Fees	$115 10	
Sales of butter, 21,787 lbs, at from 15 to 23c	4,597 83	
" cheese, 7,556 lbs., at from 8 to 11c	775 70	
" skim-milk and whey	20 10	
" cream, 21½ pints	4 33	
Contingencies, breakages	2 00	
Sales of milk and buttermilk	3 00	
Sundries—milk can, 3.75 ; old churn, 1.00 ; curd mill, 10.00	14 75	
		5,532 81
Net expenditure		$2,483 46

(b) Experimental Dairy.

Foreman (9 months)	$473 61	
Cheesemaker (9 months)	499 99	
Assistant in experimental work (9 months)	249 97	
Wages of cattleman, etc	483 71	
Purchase of milk for experiments	5,684 41	
Cows	410 06	
Feed and fodder	680 68	
Furnishings and repairs	718 83	
Fuel and light	270 46	
Laboratory expenses, chemicals, etc	1 10	
Contingencies	192 63	
Advertising, printing, postage, stationery	133 38	
Engineer (9 months)	285 00	
		10,083 83

Revenue.

Sales of butter, 25,587 lbs., at from 15 to 24c	$5,107 53	
" cheese, 8,312½ lbs., at from 7 to 12c	870 40	
" milk, 15,689¾ qts., at 4c	627 59	
" skim-milk and whey, 131,200 lbs., at 10c per cwt	131 20	
" cream, 22 gals. at 60c, 2 gals. at 80c	14 80	
" cattle :—		
7 grade calves, a few days old	15 50	
1 bull calf	10 00	
7 grade heifers	152 00	
6 dry cows	235 00	
Sale of hide	3 00	
" pasteurizer	35 00	
" 3 cheese vats	25 00	
" milk cans, 4.50 ; old churn, 5.00 ; old iron, 60c	10 10	
Fees	8 00	
		7,245 12
Net expenditure		$2,838 71

Allowing nothing for milk or cream supplied to College, value $882.18, at 4 c. per qt.

IV. POULTRY DEPARTMENT.

Wages of assistant	$414 00	
Purchase of stock	77 25	
Furnishings, repairs, etc	206 47	
Feed, etc	267 94	
Fuel, light and contingencies	180 58	
Experiments in fattening poultry	1,006 07	
		$2,152 31

REVENUE.

Sale of Eggs :			
102⅛ sets for hatching	$142 05		
80 eggs for hatching	4 00		
426¾ doz. for domestic use	82 93		
		$228 98	
Sale of Poultry :			
Live birds	$119 55		
Dressed birds	529 40		
Feathers	4 10		
		653 05	
			882 03
			$1,207 28

V. HORTICULTURAL DEPARTMENT.

Permanent Improvements		$101 10
Maintenance :		
Salary of head gardener and foreman	$700 00	
Salary of assistant gardener and florist	540 00	
Salary of assistant in greenhouses	398 32	
Teamster	382 00	
Wages of laborers	1,538 23	
Manure and fertilizers	87 75	
Seeds, bulbs, plants, trees, etc	322 83	
Furnishings, repairs, implements and tools	657 24	
Fuel and light	179 75	
Contingencies	308 22	
Fellow for 7 months	213 58	
		5,327 92
		$5,429 02

REVENUE.

Sale of vegetables	$ 2 50	
" strawberries, to officers, 33⅔ crates, at 1.00	33 67	
" fruit trees	2 50	
" old bones	2 88	
Use of garden team	6 00	
		47 55
Net expenditure		$5,418 02

NOTE.—Ordinarily there is no revenue from this department, as the produce is used by the College, and, because of complaints from Guelph market gardeners, the Department is not allowed to sell even the surplus.

VI. MECHANICAL DEPARTMENT.

Salary of foreman	$749 99	
Tools, fuel and light	125 19	
		$875 18
Total expenditure		$875 18

SUMMARY, YEAR 1902.

Total net expenditure on Maintenance Account :		
I. College and Government Buildings	$43,669 65	$43,669 65
II. Farm :		
1. Farm proper and Experimental Feeding Department	6,584 69	
2. Field Experiments	7,447 10	
		14,031 79
III. Dairy :		
1. Dairy School	2,483 46	
2. Experimental Dairy	2,838 71	
		5,322 17
IV. Poultry	1,270 28	1,270 28
V. Horticultural Department	5,418 02	5,418 02
VI. Mechanical Department	875 18	875 18
Total net expenditure, 1902		$70,587 09

S. SPRINGER,
Bursar.

INDEX.

Acid in creamery butter-making, 61.
Acidimeter, 36.
Aeration and cooling of milk, 91.
Agriculture, Report of Professor, 69.
Anthracnose of beans, 25.
Anthrax, 94.
Agriculturist, Report of, 147.
Apples, 80.
Ash constituents of cereals, 48.
Associate Diploma recipients, xiii.
Bacteriology, Report of Professor, 88.
Bachelors Science of Agriculture, xiii.
Barley, 116, 117.
Beans, 124.
Biology, 16.
Biological Laboratory, new, 16.
Biology, Report of Professor, 16.
Biology, Report of Associate Professor, 29.
Birch-borers, 22.
Bird migration, 30.
Book-keeping, 1.
Botany, 17.
Buckwheat, 119.
Buff Orpingtons, 142.
Butter, exporting in pound prints, 63.
Butter, making, 38, 39, 59-63.
Butter, water in, 38, 39, 62.
Campus, improvements in the, 86.
Cauliflower disease, 89.
Cheese, abnormal flavors, 89.
Cheese, ripening, 40, 66.
Cheesemaking experiments, 63, 66.
Chemistry, Report of Professor, 33.
Chemistry, Report of Associate Prof., 48.
Cherries, 80.
Chicken disease, new, 95.
Chicken fattening, 143.
Choke-cherry, dangerous, 28.
Clover and Grasses, 137.
Cold Storage, 6, 8.
Cold Storage plans of, 4-7.
Cooked food for fowls, 144.
Cooling and aeration of milk, 91.
Comparative tests of grain, 112.
Corn, 119, 133.
Courses of Study, vii.
Cow Peas, 122.
Cream ripening, 61.
Cream testing, 59.
Cultivation, methods of, 112.
Curds, washing, 64.
Currants, 84.
Dairy Herd, 67.
Dairy Husbandry, Report of Professor, 56.
Dairy School, 56.
Day, G. E., Report of, 69.
Dean, H. H., Report of, 56.
Dean of Residence, Report of, 1.
Diphtheria, avian and human, 98.
Diseases of live stock, 54.
Doherty, Manning W., Report of, 29.
Ducks, 142.
Egyptian Peas, 122.
English, Report of Instructor, 1.
English, Report of Lecturer, 2.
Entomology, 17.
Experimentalist, Report of, 105.
Experiments at the College, 106.
Farm Superintendent, Report of, 69.
Farmers, assistance offered, 88.
Fat percentages for butter-making, 62.
Fattening lambs, 71.
Fattening steers, 69.
Feeding and management of live stock, 75.
Financial Statement, 151.
First class men, xiv.
Fish food, 37.
Flax, 123.
Floriculture, 77.
Flour, varieties of spring wheat for, 113.
Flour mills, composition of by-products, 51.
Forestry, 77.
Fruit, cold storage of, 8.
Fruit, experiment stations, 79.
Gamble, W. P., Report of Professor, 48.
Geology, Report of Professor, 16.
Gooseberries, 84.
Graham, W. R., Report of, 139.
Grass Peas, 121.
Grasses and Clovers, 137.
Green Fodder, leguminous crops for, 135.
Hamilton sludge, 37.
Harcourt, R., Report of, 33.
Harrison, F. C., Report of, 86, 149.
Hatching Eggs, 140, 141.
Herbarium, 29.
Horse Chestnut, leaf spot, 24.
Horse-beans, 123.
Horticulture, Report of Professor, 77.
Household Science, vi.
Hulless Barley, 117.
Hutt, H. L., Report of, 77.
Laboratory Work and Analysis, 87.
Lambs, feeding experiments, 71.
Leaf Spot of horse chestnut, 24.
Leaf Spot of sugar beet, 24.

Leguminous crops for green fodder, 135.
Lentils, 123.
Librarian, Report of, 149.
Lightning, destruction by, 9.
Limestone, 41.
Lochhead, Wm., Report of, 16.
Lupines, 123.
Macaroni Wheat, 114.
Macdonald Buildings, xii.
Manual Training, vi.
Mathematics, 2.
Milk, household, 57.
Milk, over-ripe for cheese-making, 64.
Milk cans, pails, and strainers, care of, 90.
Milking to avoid bacteria, 91.
Milking, place for, 93.
Millet, 120 133.
Mills, President James, Report of, vi.
Mixtures for grain and straw, 109.
Moisture determination, 53.
Moisture and salt in butter, 62.
Moisture and salt in curds and cheese, 65.
Mountain ash, dangerous, 28.
Museum, 19.
Mustard spraying, 29.
Nature Study, vi.
Oat mills, composition of by-products, 51.
Oats, 116.
Ornithology, 30.
Over-ripe milk for cheese, heating, 64.
Quilts for chaff hives in winter, 148.
Quinces, 81.
Paper sacks for storing honey, 148.
Paraffine coating of cheese, 66.
Pasture, 135.
Pasteurization of milk, 57, 60.
Pea mills, composition of by-products, 51.
Peaches, 81.
Pears, 80.
Peas, 120, 121.
Pen *vs.* pasture feeding for swine, 72.
Physician, Report of, 150.
Physics, 2.
Physics, Report of Professor, 2.
Physics Laboratory new, 13, 14, 15.
Pink rot on bean anthracnose, 26.
Plums, 28, 80.
Potato, 125, 127.
Potato beetle, 127.
Potato rot, 28.
Potato scab, 127.
Poultry, Report of Manager, 139.
Poultry, methods in the United States, 139.
President, Report of, vi.
Public speaking, 2.
Rainfall and temperature, 15.
Rape, 134.
Raspberries, 83.
Reed, J. H., Report of, 55.
Requests, xvi.
Reynolds, J. B., Report of, 1.
Roots, 130, 132.
Roots *vs.* silage for fattening live stock, 69, 71.
Roup, 89, 98.
Rowsome, H. R., Report of, 147.
Rutherford, W. J., Report of, 1.
Rye, 115, 119.
Salt and moisture in butter, 62.
Salt and moisture in curd and cheese, 65.
Saw-fly larva injuring apples, 19.
Scholarships, 16.
Seed grain selection, 107.
Short courses, vii.
Shot-hole fungus, 25.
Skim-milk substitutes for feeding chickens, 145.
Silage *vs* roots for fattening live stock, 69, 71.
Sludge, 37.
Smut in oats and wheat, 110.
Sorghum, 134.
Soy beans, 124.
Stable bacteria, 90.
Starch mills, composition of by-products, 51.
Steer feeding experiments, 69, 70.
Stimulative feeding for bees, 149.
Strawberries, 81.
Students, number, religion, etc., vii.
Sub-soil temperatures, 11, 12.
Sugar beets, leaf spot, 24.
Sugar beets, 36, 42, 43, 128, 130, 132.
Sunflowers, 119.
Superintendence of farms, 73.
Swine feeding experiments, 72.
Temperature and rainfall, 15.
Thomas' Phosphate for sugar beets, 45.
Tobacco, new disease, 24.
Tomatoes, 85.
Turnip, 131, 132.
Turnip Fly, 131.
Vetches, 123.
Veterinarians, assistance offered, 88,
Veterinary Science, Report of Professor, 54.
Washing curds, 64.
Water in butter, 38.
Wheat, 117, 118.
Wheat for live stock, 115.
Whitby Fair Illustrated Plots, 34.
Wild plum, dangerous, 28.
Woolly Aphis, 20.

TWENTY-NINTH ANNUAL REPORT

OF THE

ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM

1903.

(PUBLISHED BY THE ONTARIO DEPARTMENT OF AGRICULTURE, TORONTO.)

PRINTED BY ORDER OF

THE LEGISLATIVE ASSEMBLY OF ONTARIO.

TORONTO:
PRINTED BY L. K. CAMERON,
Printer to the King's Most Excellent Majesty.
1904.

WARWICK BRO'S & RUTTER, Printers,
TORONTO.

TWENTY-NINTH ANNUAL REPORT

OF THE

ONTARIO AGRICULTURAL COLLEGE.

AND

EXPERIMENTAL FARM

FOR THE YEAR 1903.

GUELPH, December 31ST, 1903.

To the Honorable JOHN DRYDEN,

Minister of Agriculture :

SIR,—I have the honor to transmit herewith the Twenty-ninth Annual Report of the Ontario Agricultural College and Experimental Farm.

In this Report the work of the year 1903 has been briefly reviewed under the following heads :

PART I. REPORT OF PRESIDENT.

PART II. REPORT OF DEAN OF RESIDENCE.

PART III. REPORT OF PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH.

PART IV. REPORT OF PROFESSOR OF BIOLOGY AND GEO OGY.

PART V. REPORT OF PROFESSOR OF CHEMISTRY.

PART VI. REPORT OF LECTURER IN CHEMISTRY.

PART VII. REPORT OF PROFESSOR OF VETERINARY SCIENCE.

PART VIII. REPORT OF PROFESSOR OF DAIRY HUSBANDRY.

PART IX. REPORT OF PROFESSOR OF AGRICULTURE AND FARM SUPERINTENDENT.

PART X. REPORT OF LECTURER IN AGRICULTURE.

PART XI. REPORT OF PROFESSOR OF HORTICULTURE.

PART XII. REPORT OF PROFESSOR OF BACTERIOLOGY.

PART XIII. REPORT OF DIRECTOR OF FIELD EXPERIMENTS.

PART XIV. REPORT OF MANAGER OF POULTRY DEPARTMENT.

PART XV. REPORT OF LECTURER ON APICULTURE.

PART XVI. REPORT OF LIBRARIAN.

PART XVII. REPORT OF THE PHYSICIAN.

I have the honor to be, Sir,

Your obedient servant,

JAMES MILLS,

President.

THE ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM, GUELPH, ONT.

HON. JOHN DRYDEN, Minister of Agriculture, Toronto, Ont.

STAFF OF PROFESSORS, LECTURERS, AND DEMONSTRATORS.

— 1904 —

G. C. CREELMAN, B.S.A., M.S.....President
H. H. DEAN, B.S.A.....Professor of Dairy Husbandry
C. A. ZAVITZ, B.S.A.....Director of Field Experiments
J. HUGO REED, V.S.....Professor of Veterinary Science
G. E. DAY, B.S.A.....Professor of Agriculture and Farm Superintendent
H. L. HUTT, B.S.A.....Professor of Horticulture
J. B. REYNOLDS, B.A.....Professor of Physics and Lecturer in English
F. C. HARRISON, B.S.A., D.P.H.....Professor of Bacteriology
W. LOCHHEAD, B.A., M.S.....Professor of Biology and Geology
R. HARCOURT, B.S.A.....Professor of Chemistry
W. R. GRAHAM, B.S.A.....Manager and Lecturer in Poultry Department
H. R. ROWSOME.....Lecturer in Apiculture
W. P. GAMBLE, B.A.....Lecturer in Chemistry
M. CUMMING, B.A., B.S.A.....Lecturer in Agriculture
J. W. HOTSON, M.A.....Lecturer in Biology
MISS ALICE ROWSOME, B.A.....Assistant in Library and Instructor in French and German
F. H. REED.....Dean of Residence and Instructor in English and Mathematics
T. D. JARVIS, B.S.A.....Demonstrator in Biology
E. G. DE CORIOLIS, B.S.A.....Demonstrator in Chemistry
H. S. PEART, B.S.A.....Demonstrator in Horticulture
W. H. DAY, B.A.....Demonstrator in Physics
B. BARLOW, B.S.....Demonstrator in Bacteriology
CAPTAIN W. CLARK.....Instructor in Drill and Gymnastics

OFFICE STAFF.

W. O. STEWART, M.D.....Physician
S. SPRINGER.....Bursar
B. S. PICKETT.....Secretary

STAFF OF INSTRUCTORS, MACDONALD INSTITUTE.

W. H. MULDREW, B.A., D. Paed.....Dean
MISS M. U. WATSON.....Lady Principal
JOHN EVANS.....Macdonald Instructor in Manual Training
MISS K. T. LYMAN, M.A.....Instructor in Science
MISS HELEN GIVIN.....Instructor in Domestic Science
MISS HELEN HOLLAND.....Assistant in Domestic Science

NOTE—Mr. Creelman succeeded Dr. Mills as President, Feb. 1, 1904.

CONTENTS.

REPORT OF THE PRESIDENT vii

Agricultural Education in Canada, vii—Societies and Associations, vii—Fairs, especially our Winter Fairs, vii—Travelling Dairies and Organized Instruction in Factories, viii—Fruit Experiment Stations, ix—Dominion Experimental Farms, ix—Agriculture in Public Schools, ix- -Dairy Schools, x—Farmers' Institutes, x—Agricultural Schools and Colleges, x—College Work in 1903, xii—Macdonald Buildings, xii—Attendance, xiii—Graduates, xiv—Associates, xiv —First Class Honor Roll, xv—Scholarships and Prizes, xv—Special Work in Departments, xvi—Excursions to College, xvi—Needs of the College, xvi.

REPORT OF THE DEAN OF RESIDENCE 1

REPORT OF THE PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH .....

Instruction in English, 2—Physics, 2—Lightning, 4 - Climatic Limits, 5—Temperature *re* Seed Germination, 9—Soil Temperatures, 12—Freezing Points of Fruit Juices, 13—Cold Storage, 14.

REPORT OF THE PROFESSOR OF BIOLOGY AND GEOLOGY 17

Instruction, 17—Herbarium and Insect Collection, 18—Needs, 18—Outside Work, 19—Nature Study Class, 20—The Museum, 20—Mustard Spraying, 21—New Weeds, 24—Egyptian Pea Blight, 26—Raspberry Cane Blight, 27—Two Blights of Potatoes, 30—Injurious Insects, 32 - Pear Tree Psylla, 32—Birds observed by Wellington Field Naturalists Club, 34.

REPORT OF THE PROFESSOR OF CHEMISTRY 37

Teaching, 37—Miscellaneous Work, 38—Composition of Soils, Rich in Vegetable Matter, 38—Wheat, and Baker's Flour, 41—Soils and Fertilizers, 42—Insecticides, 43—Tests of Sugar Beets, 45.

REPORT OF THE LECTURER IN CHEMISTRY 51

Teaching, 51—By-Products of Flour, Oat, Pea and Starch Mills, 51—Chemical Changes in Ripening of Cheese, 54—Preservatives, 55 –Tests for Pure Water, 56—Alkaline Solution, 56.

REPORT OF THE PROFESSOR OF VETERINARY SCIENCE 57

Class room, 57—Diseases and Ailments of Live Stock, 59.

REPORT OF THE PROFESSOR OF DAIRY HUSBANDRY 60

The Dairy School, 60—Market Milk, 61—Testing Cream, 63—Buttermaking, 64—Cheese experiments, 66—Cocoa Shell Milk for Calves, 73 –Sugar Beet Pulp for Dairy Cows, 74—Dairy Herd, 75.

REPORT OF THE PROFESSOR OF AGRICULTURE AND FARM SUPERINTENDENT 77

Farm Superintendence, 77—Live Stock, 79—Feeding Stock, 79—Live Stock experiments, 80—Outside work, 80.

REPORT OF THE LECTURER IN AGRICULTURE 81

Teaching, 81—Swine experiments, 81—Short Keep *vs.* Long Keep Steers, 84—Cut Feed *vs.* Uncut Feed, 85—Blood Meal, 87—Feeding of Range Steers, 87.

REPORT OF THE PROFESSOR OF HORTICULTURE 88
Instruction, 88—Meetings attended, 88—Co-operative Testings of Small Fruit, 89—Orchard Crops, 90—Apples, 91—Pears, 92—Plums, 92—Cherries, 93—Strawberries, 93—Raspberries, 93—Currants, 94—Gooseberries, 94—Tomatoes, 94—Cold Storage, 94—Wax Models, 95—Needs, 95.

REPORT OF THE PROFESSOR OF BACTERIOLOGY 96
Lectures, 96—Meetings attended, 96—Publications, 97—Routine Laboratory Work, 97—Assistance to Veterinarians and Farmers, 98—Urgent Needs, 98—Research Work, 99—The Bakers' School, 99—The Tubercle Bacillus in Cheese, 100—Methods employed in Switzerland, 101.

REPORT OF THE DIRECTOR OF FIELD EXPERIMENTS 113
Field Agriculture, 113—Experimental Work, 114—Results of Experiments, 115—Weather Conditions, 115—Farm Crops in Ontario, 115—Test of Different Classes of Grain, 116—Experiments in Plant Breeding, 118—Influence of Seed Selections upon the Succeeding Crop, 118—Continuous Selection of Seed Oats for Eleven Years in Succession, 119—Grain and Straw from Different Grain Mixtures, 121—Methods of Cultivation, 121—Smut in Oats and Winter Wheat, 121—Influence of Different Latitudes on Seed Oats and Seed Wheat, 122—Grain Sown at Different Dates, 124—Winter Wheat, 125—Wheats illustrated, 126—Illustrations of Spelt and Emmer, 127—Winter Rye, 131—Spring Rye, 131—Winter Barley, 131—Spring Barley, 131—Oats, 131—Corn for Grain, 132—Millet for Seed, 132—Field Peas, 134—Hairy Vetches Grown for Seed, 135—Beans, 135—Soy, Soja or Japanese Beans, 135—Sugar Beets, 135—Potatoes, 139—Treatment for the Potato Beetle, 140—Bordeaux Mixture for the Potato Blight, 141—Mangels, 141—Swede Turnips, 143—Fall Turnips, 143—Carrots, 142—Parsnips, 144—Corn for the Production of Fodder or Silage, 144—Sorghum for Fodder, 145—Sunflowers, 145—Millet for Green Fodder and for Hay, 146—Rape, Kale, Cabbage, etc., 146—Green Fodder Crops, 145—Annual Crops for Fodder Purposes, 147—Grasses and Clovers for Pasture, 148—Mixtures of Grasses and Clovers for Hay Production, 148.

REPORT OF THE MANAGER OF THE POULTRY DEPARTMENT 152
Hatching Eggs in January, 152,—Later Hatching, 152—Experiments with Incubators, 153—A Cold House, 154—General Treatment of Breeding Stocks, 155—Andalusian Fowls, 156—Ducks, 156—Experiment in Fattening Chickens, 157.

REPORT OF THE LECTURER ON APICULTURE 159
Storing Honey for Granulation, 159—Swarming, 159.

REPORT OF THE LIBRARIAN 161

REPORT OF THE PHYSICIAN 162

FINANCIAL STATEMENT FOR 1903 163

PART I.

REPORT OF THE PRESIDENT.

Agricultural Education in Canada.

Before proceeding to a detailed account of the year's work at the College, I may make a few observations on agricultural education in this country, which observations I hope may not be considered inappropriate to the occasion.

Agricultural Education may be spoken of as a plant, but a slow-growing plant, so far as the Dominion of Canada is concerned. This plant was set out in these Provinces many years ago; but through the opposition of those who were wedded to academic ideals in education, and the no less persistent but utterly unaccountable opposition of the farmers throughout the country, it was stunted at the beginning and not allowed to grow much for a long time. It struggled on, however, for a generation or more, till at length it became a respectable sapling; and now, I am pleased to say, it shows signs of becoming a large and valuable tree.

Apart from schools and colleges, we have had in this country a number of agencies which have assisted indirectly in the work of agricultural education,—agricultural papers and periodicals, agricultural societies, live stock and dairy associations, horticultural societies, farmers' institutes, and similar organizations. The influence exerted by these agencies is well understood; it varies in kind and degree, but always contributes towards education on practical lines.

Societies and Associations.

We have Agricultural Societies, a Dominion Horse Breeders' Association, a Cattle Breeders' Association, a Sheep Breeders' Association, a Swine Breeders' Association, Poultry Associations, Dairy Associations, a Fruit Growers' Association, a large number of Horticultural Societies, an Entomological Society—all receiving regular grants from the Provincial Legislature, holding annual meetings, delivering addresses, reading and discussing papers, and publishing annual reports for distribution among farmers.

The most notable advance in the work of our Agricultural Societies for some time has been the sending of expert judges to the fall fairs, to judge live stock and fruit, and give publicly the reasons for their awards for the benefit of those who may be present when the judging is done. This arrangement is working well and the results seem quite satisfactory.

Our Fruit Growers' Association publishes a monthly journal and has recently introduced the practice of holding series of orchard meetings for brief addresses and practical demonstrations in pruning and in spraying for the destruction of insects and fungous diseases. The meetings are arranged for by the Secretary of the Association, and there is no doubt that the move is a step in the right direction.

Fairs, Especially Our Winter Fairs.

We have township and county fairs all over the country, spending in the aggregate a large sum of money and in many instances with very questionable results. No doubt they show fairly well what can be done by the best practice of each locality in grain growing, root cultivation, stock raising, and fruit culture; but in order to secure a good or even a fair attendance at these fairs, the Directors not unfrequently introduce what they call "attractions," such as horse racing and various kinds of side shows in which fakirs and mountebanks vitiate the taste of our young people and turn their attention away from the real objects of the show. This is certainly to be regretted; and we are glad to notice signs of a determination to remove these objectionable features.

We have also several large annual fairs at central points, such as Halifax, St. John, Ottawa, Toronto, London, and Winnipeg. These and other fairs of the same class have considerable educational value,—especially the Industrial Fair of Toronto, which is said by some well-travelled Canadians, and not a few visitors from the United States, to be the best annual fair on this continent.

Further, within the last five or six years, we have held what we call Winter Fairs at Guelph in Western Ontario, Ottawa in Eastern Ontario, and Amherst in Nova Scotia. These fairs are held in large buildings erected for the purpose, and consist of exhibits of fat cattle, fat sheep, bacon hogs, dairy cows, and poultry. In each Winter Fair building, there is a slaughter house; a room for hanging, and examining, and comparing carcasses of beef, mutton, and pork; and a galleried auditorium for lectures and demonstrations, given, first, on the live animals after the prizes have been awarded, and subsequently on the carcasses of the animals that got the prizes,—both exhibited, examined, and discussed on the dais of the auditorium in the presence of large numbers of farmers, who observe, listen, and ask questions during the last four days of the show. The poultry also, living and dead,—usually a very large exhibit,—is judged, and both live and dead birds are then taken to the auditorium to be exhibited and discussed by experts in presence of the people.

In our judgment, these Winter Fairs have great educational value and do much to enlighten and improve the farmers of the country.

Travelling Dairies and Organized Instruction in Creameries and Cheese Factories.

In June, 1891, we started a Travelling Dairy in the Province of Ontario,—consisting of a span of carriage horses; a good spring waggon, with a regular carriage top in front, and a box for home dairying appliances, with a tarpaulin cover behind; a first-class butter maker; the necessary supply of utensils, and a good dairyman as lecturer in charge. We sent out one such dairy the first year, and three the second year, and we kept them at work for six years—from May to November each year—till the whole Province was covered. Nova Scotia has since sent out two similar dairies in charge of young women from our Guelph Dairy School, with two men to drive the teams and do the heavier and rougher part of the work. And I need scarcely say that the results in both Provinces have been eminently satisfactory. There has been a marked improvement in the quality of the butter, both in hotels and in private houses, throughout these Provinces; much more butter is consumed, and higher prices are paid for it.

For some years past, the Dairy Associations in the Province of Ontario have sent instructors regularly to creameries and cheese factories which desired the assistance of such instructors, and were willing to pay $5 each towards the expense, but recently the work has been taken over by the Minister of Agriculture for the Province, and the results are much more satisfactory. Acting through the Superintendent of Farmers' Institutes, the Minister appointed two of the best men he could get to organize and take charge of the work, one for the eastern part of the Province, and the other for the west. These men grouped into syndicates of 20 or 25 each those creameries and factories which desired instruction and were willing to pay $15 apiece for the year. They then selected their instructors, and sent one to each group—27 instructors, under two directors, to look after the work in 79 creameries and 600 cheese factories last season. Similar instruction is given in the Province of New Brunswick, and the results in both Provinces are most gratifying—a great improvement in the factories, especially in the matter of drainage, and cooler and more equable temperatures in the curing rooms; greater cleanliness; better methods; larger product from milk, and higher prices for butter and cheese. It is likely that most of the factories in the Province of Ontario will ask for instruction next year, as none of them can afford to fall far behind in the race.

Fruit Experiment Stations.

We have in the Province of Ontario eleven fruit experiment stations and two sub-stations for testing varieties of fruit,—their characteristic and intrinsic merits, the soils to which they are adapted, and the climatic conditions under which they may be expected to thrive. The stations are controlled by a Board of six persons,—the President of the Agricultural College, the Horticulturist of the Agricultural College, the Secretary of the Fruit Growers' Association, and three expert fruit growers elected annually by the Fruit Growers' Association. The organization is very simple and inexpensive. Instead of buying land, erecting buildings, and appointing employees in different localities, the Board selected reliable, wide-awake fruit-growers, who had good orchards or plantations at the various points at which it wished to make tests,—one for peaches, another for pears, a third for grapes, a fourth for apples, a fifth for plums, a sixth for cherries, a seventh for small fruits, an eighth for hardy apples, and so on, until it had covered fairly well the different soils and climatic conditions of the Province; and each of these chosen growers was asked—(1) to report carefully once a year, according to instructions submitted, on his specialty, say, peaches; (2) to report on all other fruits which he might be growing; and, (3) to plant, take care of, and report upon all varieties of his specialty which the Board might send him from time to time—on condition, first, that the Board would pay him a certain sum in cash, say, $150 to $175 a year, when his annual report was received and approved; and, second, that the varieties given him to test should become his property, with the privilege of removing after a given time all which might prove to be worthless. These stations are all visited once a year and reported upon by the College Horticulturist or Secretary of the Fruit Growers' Association.

In this way the Board managed to get on without any capital investment; it got quick returns, and in ten years it has done a large amount of valuable and instructive work for a small expenditure, varying from $2,600 to $3,100 a year,—including an allowance of $250 a year to our Secretary for writing and illustrating a description of "The Fruits of Ontario," to be published two years hence.

Dominion Experimental Farms.

We have five Dominion Experimental Farms under the directorship of Dr. William Saunders, of Ottawa, with a local staff to take charge and do the work on each farm. The Central Experimental Farm, at Ottawa, consists of 465 acres of land, equipped and manned for extensive experimental work in soil cultivation and crop growing; stock breeding, feeding, and management; poultry raising; beekeeping; dairying; fruit growing; the testing of ornamental shrubs and trees; chemical research; botanical and entomological investigations; plant breeding, etc.

The other four farms are located where they are most needed to test varieties of crops and conduct experiments in the different parts and conditions of the country,—one at Nappan, Nova Scotia, for the Maritime Provinces; one at Brandon, for Manitoba; one at Indian Head, for the North-West Territories; and another at Agassiz, for British Columbia.

Agriculture in Public Schools.

Agriculture is a subject on the fixed program of Public School studies in two Provinces of the Dominion,—for Forms IV. and V. of all rural Public Schools in the Province of Ontario, and for both Public and High Schools throughout the Province of Manitoba. In the North-West Territories, also, agriculture is a compulsory subject in all schools, including the Normal School.

Agriculture is now an optional subject in the schools of four Provinces—Quebec, British Columbia, New Brunswick, and Nova Scotia; but Nature Study lessons bear-

ing on agriculture form a part of the prescribed course of study for Public Schools in the two latter Provinces.

So far the difficulty has been with the teachers, as only a few of them are qualified to teach either agriculture or nature study; but this difficulty can be overcome by requiring the Normal Schools to give thorough courses of training in these subjects; and it is difficult ot understand why action on this line should be delayed by any Province which has placed both or either of these branches on the fixed program of studies for its Public Schools.

Dairy Schools.

We have six Dairy Schools in the Dominion,—three in the Province of Ontario, one in Quebec, one in New Brunswick, and one in Manitoba. These schools are well manned and fully equipped for giving the broadest and most thorough instruction and practical training in milk testing, butter-making, and cheese-making,—offering long and short courses, free of charge, for farmers' sons and daughters, and for professional buttermakers and cheesemakers from all parts of the Dominion.

Farmers' Institutes.

These organizations do college extension work, and when properly organized and well managed, their methods and work are the most effective means known to the people of this continent for stirring up, instructing, and benefiting the farming community. We have an excellent system of Farmers' Institutes in Canada, founded in the Province of Ontario, and afterwards extended to the other Provinces; and there is no doubt that the work done by them has contributed largely towards an improvement in the condition of Canadian farmers—a very marked improvement in material things, intelligence, and social standing.

Agricultural Schools and Colleges.

Canada is only beginning to realize that it is a country,—that it has a great future before it. Hence, it has only one Agricultural College, properly so called. There is an Agricultural School at Truro, Nova Scotia, which the Legislature of that Province is enlarging, with a view to make it a strong and successful college; the Province of New Brunswick is planning for a College of Agriculture at Fredericton; the Province of Quebec has a number of small Agricultural Schools, most of them in connection with church institutions; Manitoba has lately passed an Act to establish an Agricultural College in that Province; and the Province of Ontario has what is known as the Ontario Agricultural College and Experimental Farm, at Guelph. This College was founded by Act of the Provincial Legislature in the year 1873, and was opened in May, 1874, so it is now in its thirtieth year. It has a farm of 550 acres; commodious farm, dairy, poultry, and horticultural buildings; a good representation of cattle, sheep, swine, and poultry; a large garden, half a dozen greenhouses, an orchard, a lawn, and an arboretum for practical work in horticulture; a good dairy herd, with buildings and equipment for instruction and practical work in handling milk and cream, testing milk, making butter, and making cheese;; five laboratories,—physical, chemical, biological, bacteriological, and horticultural, and nearly all that is required in the way of class rooms and museums. To this there has recently been added a large and well-equipped department for instruction and practical training in Home Economics (or Domestic Science), Nature Study, and Manual Training.

In this College three things have been aimed at:

First and chiefly, to educate young men for work and life on the farm.

Second, to do experimental work, in order, if possible, to solve some of the problems that confront Canadian farmers.

Third, to lead and encourage farmers in outside undertakings, which from time to time seem likely to benefit the farming community; such, for instance, as the Farmers' Institutes, the Travelling Dairies, and the Fruit Experiment Stations.

This Guelph College has no department of mechanic arts,—a department which is the strongest and most largely attended in nearly all United States Agricultural Colleges; and Guelph did not admit women, except to the Dairy Department, until September, 1903.

It gives the following courses of study, with a large amount of practical training:

(1) A Two-year Course,—intended specially for work and life on the farm. In this course the departments of instruction and practical training are: English; elementary mathematics; the sciences bearing on agriculture; an outline of political economy; and with special emphasis always and everywhere from beginning to end, the practical subjects,—agriculture, live stock, dairying, and horticulture. This leads to the Associate Diploma, and is called the Associate Course.

(2) A Three-year Course. Those who reach a fixed standard in the theory and practice of the two-year course, and give promise of being good practical men, are allowed to take a third year's work, and write for a Specialist Certificate in Agriculture or Horticulture.

(3) A Four-year Course. Those who reach a higher standard in general scholarship and practical knowledge in the two-year course,—higher than that required for the three-year course,—may take two years additional work, and write for the B.S.A. degree.

(4) Short Courses. (1) A two-weeks' course in live stock and grain judging; (2) a three-weeks' creamery course; (3) a four-weeks' course in poultry raising; and (4) a twelve-weeks' course in dairying, including milk testing, butter-making, and cheese-making.

Of the College at Guelph, it may, I think, be truthfully said, "This one thing it does"—it runs everything on agricultural lines. It does not make Public School teachers; it does not make mechanics; it does not make professional men—it simply makes farmers. It has farm surroundings, an agricultural atmosphere, and agricultural enthusiasm; and of the young men who go there from the farm, 95 per cent. return to the farm with a training that will make them more progressive and successful workers, will give them an increased liking for farm life, and will beget in them a greater respect for farmers and farming, with a feeling that the man who works with both his hands and his head is not for that reason any less of a gentleman than the man who works with his head alone. During the fall term, just passed, there were 248 students in the regular course, and there will be about 350 in the short courses for the year.

A considerable amount of experimental work is done from year to year in the Live Stock, Dairy, Poultry, and Horticultural Departments at the College; and a good deal of time is devoted to research in the Physical, Chemical, Biological, and Bacteriological Laboratories; and Field Experiments are gone into on an extensive scale, including variety tests, etc., on the College farm, and co-operative work on something over 3,000 farms throughout the Province.

After long years of hard work the Ontario Agricultural College may, I think, fairly claim to have made Guelph the Mecca of Ontario farmers. The farmers go there in large numbers every year. The Farmers' Institutes, by correspondence with the President of the College, arrange from year to year to run farmers' excursions to the College in the month of June, at which time the farmers and their families visit the College in large numbers, varying from 25,000 to 30,000 a year for the last six or seven years.

At this stage one naturally asks, What are the results from these various agencies working together along the line of agricultural education? and the answer is:

1st. The farmers of this country are producing more per unit than formerly. For example, take the Province of Ontario. During the last ten years the population of this Province has remained stationary, and there has been little, if any, increase in the price of farm products; and, nevertheless, there has been a very large increase in the sums received for the agricultural products exported from the Province.

2nd. Our farmers are living better, getting more of the necessaries and comforts of life for their labor.

3rd. They are more intelligent. Evidence of this is seen in the fact that they are reading more than formerly, and are much more anxious for knowledge. It is seen also in the character of the discussions at the Farmers' Institutes.

4th. They are more refined, dress better, and look better than in days gone by.

5th. During the last fifteen years, there has been a general and clearly noticeable uplift of the farming community in this country. I have had ample opportunities for studying the situation in this Province; I have seen pretty much the same people —20,000 to 30,000 a year—for a number of years, and I have no hesitation in making the statement.

6th. Farmers are less inclined than formerly to apologize for themselves and their occupation; and their social standing is improving from year to year.

College Work in 1903.

There is nothing special to report regarding the routine work at the College during the past year. The different departments have been occupied pretty much as usual, but with an increased determination to extend the work of research on various lines,—due, no doubt, in some measure at least, to the growing desire of farmers all over the country for information and advice regarding soil cultivation, crop growing, the breeding and management of live stock, poultry raising, fruit growing, and the destruction of weeds, insects, and fungous diseases, etc.

The bulletins prepared by members of the College staff and published by the Department of Agriculture during the past year are as follows:

No. 126—"Peas and the Pea Weevil," by C. A. Zavitz and W. Lochhead.

No. 127—"Farm Poultry," by W. R. Graham.

No. 128—"The Weeds of Ontario," by F. C. Harrison and W. Lochhead.

No. 129—"Bacon Production," by G. E. Day.

No. 130—"Bacterial Content of Cheese Cured at Different Temperatures," by F. C. Harrison and W. T. Connell.

No. 131—"Ripening of Cheese in Cold Storage compared with Ripening in Ordinary Curing Room," by H. H. Dean and R. Harcourt.

No. 132—"Roup: An Experimental Study," by F. C. Harrison and H. Streit.

No. 133—"Present Condition of San Jose Scale in Ontario," by W. Lochhead.

Macdonald Buildings.

Early in the spring of 1903, the contractor commenced work on what are known as the Macdonald buildings—Macdonald Institute, and Macdonald Hall. The former is to furnish long and short courses in Home Economics (or Domestic Science), Nature Study, and Manual Training,—all three for teachers, male and female, and the Home Economics for farmers' daughters and other young women who desire to learn the theory and practice of cooking, ventilation, general housekeeping, laundry work, sewing, dressmaking, millinery, home decoration, etc. The latter is a woman's residence, or a large and well-equipped building in which the young women who come to take any of the courses can have good board, lodging, etc., on easy terms, and under proper oversight, during their stay at the College.

The Institute is a fine building of red pressed brick, with terra-cotta trimmings,—large and imposing in its general outline, commodious in its internal arrangement, and

elegant as regards the quality and finish of the inside woodwork. The Hall (which will be ready for use in September next) will also be a large and imposing brick building, with stone trimmings and of the Elizabethan style of architecture. It will be well furnished, and will provide a very comfortable home for 107 young women, some in single rooms and others in double rooms, with single iron beds.

Students in Attendance.

The total number of students registered for work at the College in 1903 was 728, as follows :

General Course	299
Specials in General Course Work	23
Dairy Courses	114
Short Course in Stock and Grain Judging	216
Second Short Course in Stock and Grain Judging	35
Short Course in Poultry Raising	11
Nature Study, Short Course during May and June	9
Macdonald Institute, Regular Course	21
Total in all courses	728

Analysis of College Roll (General Course, 1903).

1. From Ontario.

Brant	10	Huron	8	Prescott	2
Bruce	8	Lambton	4	Prince Edward	3
Carleton	2	Lanark	5	Renfrew	2
Dufferin	6	Leeds	3	Russell	2
Dundas	8	Lincoln	8	Simcoe	9
Durham	4	Middlesex	7	Stormont	2
Elgin	11	Muskoka	3	Victoria	1
Essex	5	Norfolk	2	Waterloo	3
Frontenac	1	Northumberland	2	Welland	1
Grenville	1	Ontario	3	Wellington	11
Glengarry	3	Oxford	5	Wentworth	11
Grey	8	Parry Sound	1	York	12
Halton	3	Peel	3	Toronto	12
Hastings	6	Perth	4	Total	205

2. From Other Provinces of the Dominion.

Manitoba	2	Nova Scotia	15	Assinboia	2
British Columbia	3	P. E. I.	2		
New Brunswick	5	Quebec	13		42

From Other Countries.

Argentine	19	Grenada	1	Sweden	1
Asia Minor	1	India	1	United States	10
Australia	1	Jamaica	5	Uruguay	1
Austria	1	Mauritius	1		52
Brazil	1	Scotland	1		
England	7	Spain	1		

Total in General Course	299
Total in General and Dairy Courses	413
Total in all courses	728

Ages and Religious Denominations.

The limits of age of students in the General Course, 1903, ranged from 16 to 49 years. The average age was 20. The religious denominations were represented as follows :

General Course—87 Presbyterians, 86 Methodists, 52 Episcopalians, 26 Roman Catholics, 24 Baptists, 8 Disciples, 4 Congregationalists, 2 Friends, 2 Lutherans, 2 Mennonites, 1 Christadelphian, 1 Christian Association, 1 Greek Orthodox, 1 New Jerusalem, 1 United Brethren, 1 Universalist,—290.

Dairy Course—41 Methodists, 39 Presbyterians, 13 Episcopalians, 7 Baptists, 7 Roman Catholics, 2 Congregationalists, 2 Disciples, 1 Friend, 1 Latter Day Saint, 1 no church,--114.

Counties Represented in 1903.

It will be noted in the analysis of the College Roll that 40 Ontario counties and districts were represented in the General Course in 1903. There were 12 from York, 11 each from Elgin, Wellington, and Wentworth ; 10 from Brant, 9 from Simcoe, 8 each from Bruce, Dundas, Grey, Huron, and Lincoln ; 7 from Middlesex ; 6 each from Dufferin, and Hastings ; 5 each from Essex, Lanark, and Oxford ; and smaller numbers from other counties.

Bachelors of Science of Agriculture.

The examinations for the degree of B.S.A. were held in the month of May, and the successful candidates, sixteen in number, received their dgrees at the commencement exercises of the University in June. The list was as follows :

Broderick, F. W.....St. Catharines, Lincoln, Ont.
De Coriolis, E. G.....Forest Side, Mauritius.
Eftyhithes, B. M.....Erekley at Iconium, Asia Minor.
Elderkin, D. T.....Amherst, Nova Scotia.
Galbraith, D. H.....Ellesmere, York, Ont.
Ketchen, A. P.....Brucefield, Huron, Ont.
Klinck, L. S.....Victoria Square, York, Ont.
La Pierre, L. A.....Paris, Brant, Ont.
McDonald, W. T.....Teeswater, Bruce, Ont.
Newman, L. H.....Andrewsville, Lanark, Ont.
Peart, H. S.....Nelson, Halton, Ont.
Rivara, J. B.....Buenos Ayres, Argentine Republic.
Rive, H.....Guelph, Wellington, Ont.
Rutherford, W. J.....South Mountain, Dundas, Ont.
Sharp, T. H.....Spanishtown, Jamaica.
Silcox, F. H.....Iona, Elgin, Ont.

Recipients of Associate Diplomas.

The following 36 students, having completed the Two-year Course, received Associate Diplomas in the usual way :

Albright, W. D.....Beamsville, Lincoln, Ont.
Baker, R. G.....Swathmore, Penn., U. S. A.
Barberree, G. L.....Corwhin, Halton, Ont.
Bell, H. G.....Orangeville, Dufferin, Ont.
Bower, J. E.....Harriston, Wellington, Ont.
Brereton, F. E.....Bethany, Durham, Ont.
Bustamante, D.....Jujuy, Argentine Republic.
Cameron, R. R.....Ailsa Craig, Middlesex, Ont.
Cohoe, W. J.....New Durham, Oxford, Ont.
Craig, J.....Glasgow, Scotland.
Davison, J. H.....Starrat, Parry Sound, Ont.
Eddy, E. D.....Scotland, Brant, Ont.
Esmond, C. W.....Blessington, Hastings, Ont.
Evens, J.....Randolph, Simcoe, Ont.
Granel, J.....Buenos Ayres, Argentine Republic.
Groh, H.....Preston, Waterloo, Ont.
Ketchen, A. P.....Brucefield, Huron, Ont.
Ledrew, H. H.....Toronto, York, Ont.
Leitch, A.....Cornwall, Stormont, Ont.
Lennox, W. J.....Newton Robinson, Simcoe, Ont.
McCaulay, J. W.....Winnipegosis, Manitoba.
McDonald, D. J.....Crawford, Grey, Ont.

MacRae, C. M. ..... Cumberland, Russell, Ont.
McFadyen, H. ..... Caledon, Peel, Ont.
McKillican, W. C. ..... Vankleek Hill, Glengarry, Ont.
Martinez, K. C. ..... Santa Fe, Argentine Republic.
Murray, R. S. ..... Toronto, York, Ont.
Panelo, F. ..... Buenos Ayres, Argentine Republic.
Pearce, S. M. ..... Iona, Elgin, Ont.
Reed, F. H. ..... Georgetown, Halton, Ont.
Rutherford, W. J. ..... South Mountain, Dundas, Ont.
Scott, P. ..... Waubuno, Lambton, Ont.
Taylor, F. ..... Cumberland Mills, Quebec.
Teeple, H. ..... Jaffa, Elgin, Ont.
Westover, C. A. ..... Frelighsburg, Quebec.
Winter, H. ..... Wicklow, Northumberland.

First-Class Men.

The work of the College is divided into departments, and all candidates who obtain an aggregate of seventy-five per cent. of the marks allotted to the subjects in any department are ranked as first-class men in that department. The following list contains the names of those who gained a first-class rank in the different departments at the examinations in 1903, arranged alphabetically:

First Year.

Bracken, J., Seeley's Bay, Leeds, Ont., in four departments: English and Mathematics; Physical Science; Biological Science; Agriculture.

Ballantyne, R., Sebringville, Perth, Ont., in one department: Biological Science.

Colwell, H. H., Toronto, Ont., in two departments: English and Mathematics; and Physical Science.

Hamilton, C., Dundela, Dundas, Ont., in one department: Biological Science.

Hart, F. C., Wallace Bay, N.S., in two departments: Physical Science; Biological Science.

McMillan, H. R. Aurora, York, Ont., in two departments: English and Mathematics; Biological Science.

Munro, J. F., South End, Welland, Ont., in one department; Biological Science.

Stayner, H. S., Toronto, Ont., in one department: Biological Science.

Tucker, H. S., Chapman, Hastings, Ont., in one department: Biological Science.

White, G. G., Perth, Lanark, Ont., in one department: Biological Science.

Second Year.

Albright, W. D., Beamsville, Lincoln, Ont., in one department: English and Economics.

Bower, J. E., Harriston, Wellington, Ont., in one department: English and Economics.

Bustamante, D., Jujuy, Argentine, in one department: Biological Science.

Craig, J., Glasgow, Scotland, in one department: English and Economics.

Deachman, R. J., Gorrie, Huron, Ont., in one department: English and Mathematics.

Esmond, C. W., Blessington, Hastings, Ont., in two departments: English and Economics; Physical Science.

Howitt, J. E., Guelph, Wellington, Ont., in three departments: English and Economics, Physical Science, Biological Science.

McKellican, W. C., Vankleek Hill, Prescott, Ont., in one department: English and Economics.

Wade, R. W., Smithville, Lincoln, Ont., in one department: English and Economics.

Scholarships.

Scholarships of $20 each in money were awarded for groups of subjects in first-year work, as follows: Highest standing, with a minimum of forty per cent. of the marks

for each subject, and an aggregate of seventy-five per cent. of the total number of marks allotted to the subjects in the group :

I. English, Mathematics, Bookkeeping, and Drawing—H. R. McMillan, Aurora, York Ont.

II. Physics, Chemistry, and Geology—F. C. Hart, Halifax, N.S.

III. Botany, Zoology, and Horticulture—R. Ballantyne, Sebringville, Perth, Ont.

IV. Agriculture, Dairying, Poultry, Apiculture, and Veterinary Science—W. D. Albright, Beamsville, Lincoln, Ont.

Prizes.

Prizes were given, each $10.00 in books, as follows :

1. Essay on "George Eliot as a Novelist and a Writer of English Prose"—J. Craig, Glasgow, Scotland.

2. First in general proficiency on first and second year work, theory and practice,—W. D. Albright, Beamsville, Lincoln, Ont.

Governor-General's Silver Medal.

Highest in general proficiency, second year, 1902-03,—J. E. Howitt, Guelph, Wellington, Ont.

Special Work in Departments.

I have been in the habit of reviewing briefly the work of each Department for the year, emphasizing the points of immediate practical importance, with a view to assist ordinary farmers in gleaning from our annual report, without too much reading, the facts and results which are of most value to them ; but having occupied considerable space with notes and observations on "Agricultural Education," I shall refrain from attempting any review of departmental work this year.

June Excursions to the College.

The number of excursionists, chiefly farmers and their families, who visited the College in the month of June last, was larger than usual. According to railroad reports, there were between 35,000 and 40,000,—the same people, or most of them the same, coming from year to year for an outing and to learn what they can from the many branches of agricultural work that are carried on at the farm.

Needs of the College.

The most urgent needs of the College at the present time are increased dormitory accommodation; an Insectary for practical work in entomology; a large building furnished with shafting, electric power, etc., for operating, comparing, and studying implements of different kinds during the winter months, when students have but little opportunity for practical work in the ordinary outside departments; and, last but not least, a new Bacteriological Laboratory, with a good isolation stable, for instruction and research in the boundless field which opens up before the investigator in this very important branch of scientific work,—closely connected, as it is, with soil fertility, dairying, stock raising, and every form of disease which afflicts man or beast. What a blessing it would be if the bacteriologists should succeed in finding, say, for hog cholera or for typhoid fever, such an antitoxin as they not long ago found for diphtheria. And, in conclusion, it may not be amiss to call attention to the fact that the State of Michigan, U.S.A., has recently provided for its Agricultural College, Lansing, a Bacteriological Laboratory at a cost of $55,000, raised by direct taxation on the property of the State,—$30,000 for the building and $25,000 for equipment.

Guelph, Dec. 31, 1903.

JAMES MILLS,
President.

PART II.

THE DEAN OF RESIDENCE.

To the President of the Ontario Agricultural College :

Sir,—I take much pleasure in presenting herewith a report of my first year's work as Dean of Residence and Instructor in English.

As Dean of Residence, it has been my duty to preside over the students' dining-room, to examine from time to time the college furniture, to supervise the care of the residence building and all needed repairs, to superintend evening study, and to direct the students as to conduct and duty.

My relations with the students and my work among them as Dean of Residence have been enjoyable. This has been due largely, I think, to the manly spirit displayed by all the students, and to the decidedly improved tone prevailing throughout the College. Considering the crowded condition of the dining-room, the conduct of the students has been very gratifying. Despite the fact that the room has been overcrowded, the order and decorum of the students have been good.

A marked respect is shown by the students for the rights of their fellow-students. Consequently almost all closely observe the regulations pertaining to study hour. The abundant physical energy of the students finds constant relief in outside work and in college athletics ; and to this fact, largely is attributable the order and quietness prevailing throughout the study hour. Moreover, as the term advances, closeness of application and systematic work become more and more characteristic of the study. Many who, on entering the college halls, found it almost impossible to concentrate their mental power for an hour at a time, have not only learned how to accomplish much in that time, but also can with ease apply themselves for a much longer period.

In the classroom, my energy has been devoted to the teaching of English Literature, English Grammar, English Composition, and Bookkeeping. In the teaching of English, it has been my aim not only to develop the ability of correct and artistic expression, but also the power of acute logical thinking, thereby attaining a good practical mastery of our mother tongue. In Grammar, besides seeking to give the students a knowledge of the correct forms of words with their inflections and governing laws, I have always considered their syntactical use. In Literature, the study has been directed with a view to broadening the student's field of thought, extending his vocabulary, enhancing his style of writing, and in developing in him a love for good literature by a study of a few standard authors. In Composition, my object has been to enable the student to think and to express his thoughts in a clear, precise, strong, and elegant manner. To this end, a study of the various structures of the sentence has been followed by a study of the arrangement and relation of sentences as combined in the paragraph, and the relation of the paragraph to the whole composition. I have sought to have the students write an essay every two weeks on such topics as the following : "The College Sale," "The Winter Fat Stock Show," "Agricultural Education," "The Macdonald Institute," and "The Grand Trunk Pacific." These essays I have examined and taken up in the class, pointing out their prominent defects. In the writing of these compositions, I have always demanded an outlining of the essay before the writing of it.

The course in Bookkeeping comprises business correspondence, commercial forms, and the keeping of a set of practical farm accounts.

In closing, I would remind you that the college residence is entirely inadquate for the accommodation of the number of students now in attendance.

I am, yours respectfully,

J. A. McLEAN,

Dean of Residence.

PART III.

THE PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to submit herewith my ninth annual report in the Departments of Physics and English.

Instruction in English.

The work in this department has gone forward with good success. There being no one person whose sole duty is the teaching of English, it is subdivided, those who teach it having work in other departments also. The Dean of Residence teaches the English literature, grammar, and composition, of the First and Second Years. The Associate Professor of Agriculture has charge of instruction in public speaking, given principally to the Second Year. The Third and Fourth Year English is taught by myself. Much of this instruction is, therefore, given against the pressure of many duties, proceeding from scientific and practical departments. There is danger, with the increase of those duties from year to year, that the work in English may suffer from enforced neglect. To judge from the growth of the College in the last four years, I am of opinion that the time is close at hand when it will be advisable to place all the English under the charge of a professor who will be able to devote all his time to it, and give it all the attention its importance demands.

Meanwhile it is gratifying to note the continued interest that the students of all years display in the English studies, and to observe the very marked improvement in all directions,—in writing, in speaking, and in the interpretation of literary masterpieces. It is gratifying, also, to learn from the University examiner in English that the graduating class of last year excelled in the correctness and precision of their answers, and in the general character of their English papers. This improvement is due in part to the lengthening of the course, from the diploma to graduation, to two years, while the amount of English read in the two years does not exceed that formerly read in one year. A deeper and a more accurate knowledge of the authors and their periods is the result. We may conclude that the extent of English studies is now properly proportioned to the needs and requirements of the classes, and to the other branches of study.

Instruction and Investigation in Physics.

The Department of Physics is now situated in the new Biology-Physics Building, with ample quarters. The generosity of the Legislature in its annual appropriation has enabled this department to become fairly well equipped in apparatus. A number of appliances very useful in instruction and investigation are still wanting, but we hope to be able to secure these at an early date.

In February of this year, Mr. McCalla, B.S.A., Fellow in Physics, resigned, and Mr. H. S. Arkell, B.A., was temporarily appointed to the position, Mr. Arkell's purpose being to proceed with his B.S.A. course this autumn. In April, Mr. W. H. Day, then a senior student at Toronto University, and since graduated with Honors in Physics, was appointed Fellow in Physics. In August he was advanced to the position of Demonstrator. Mr. Day has proved to be a most capable teacher and demonstrator. His six years' experience in Public School teaching, and his thorough course in Physics at the University, enable him to perform with efficiency the duties of Demonstrator,—a work very important in the present methods of teaching science.

The work of instruction in Physics is now subdivided and classified as follows :

First Year.—Mechanics, being a laboratory course, supplemented by lectures, in the principles of machinery ; mechanics of water supply,—a study of appliances for conveying water, such as pumps, windmills, siphons, hydraulic rams, etc.; an elementary course in soil physics,—a study of the structure of soil, its physical properties, and the movement of air and water through it ; elementary physics,—to lay the foundation for the above work, and for that of the Second Year. This consists of a brief course in hydrostatics, the use of balances, weighing and measuring by the metric system, etc.,—all in the winter term.

Second Year.—In the winter term, a review and an extension of the above divisions; in the autumn, a course in Surveying and Levelling for drainage plans. In surveying, students learn by practice the various uses of the surveyor's chain, in measuring areas of different shapes. In levelling, a field is selected and by means of levelling instruments a report of the elevations and dpressions in the surface is obtained, from which a contour map is made, and then the courses of drains marked out, with tables showing directions, depths, and slopes.

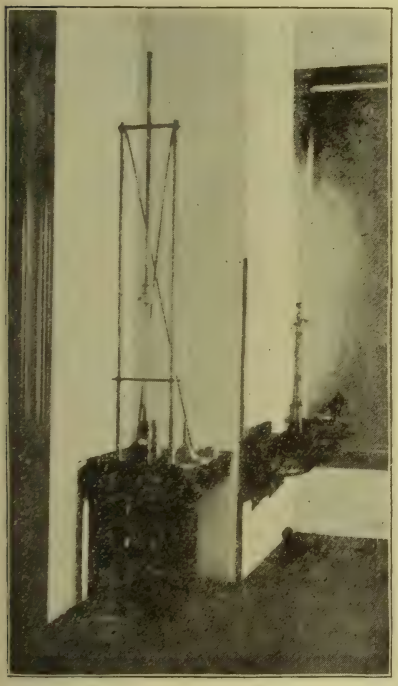


Fig. 1. Soil compacting machine for filling tubes with soil uniformly.

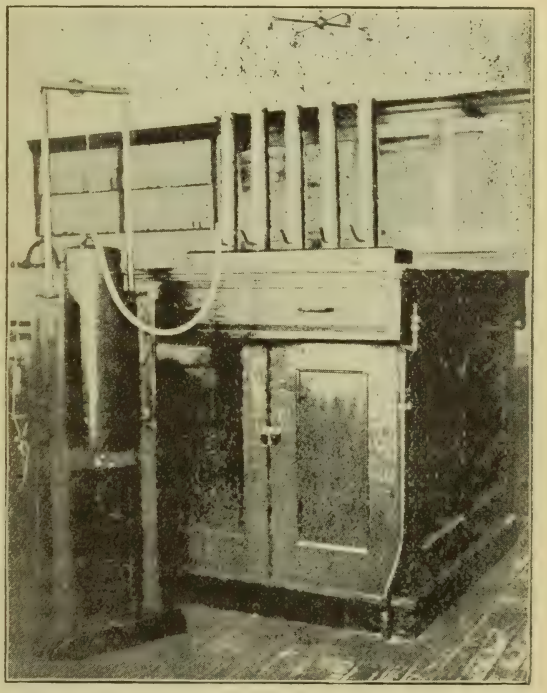


Fig. 2. Aspirator and tubes for examining the movement of air in soils.

Third Year.—Courses of lectures and practical work in Heat, Meteorology, and Cold Storage, covering the whole year.

Fourth Year.—Courses, covering the whole year, of lectures and laboratory investigation in Heat, Refrigeration, and the Physical Properties of the Soil ; Climatology, being principally a study of the Climate of Canada in relation to Agriculture, and involving a course of lectures, and the preparation by students of charts of rainfall and temperatures for different points in Canada.

REPORTS OF INVESTIGATIONS.

I. Lightning Report.

The losses by lightning stroke reported this year are fewer in number, and their amount much less, than in either of the two years preceding. A comparison of the three years gives the following result :

Analysis of Species of Trees Struck.

	Elm.	Pine.	Basswood.	Oak.	Maple.	Ash.	Hemlock.	Poplar.	Willow.	Beech.	Chestnut.	Balsam.	Apple.	Hickory.	Total.
1901	7	8	5	1	2	....	2	....	....	....	1	....	....	....	26
1902	6	1	2	5	4	2	....	1	1	1	....	1	....	1	25
1903	5	3	....	1	....	1	....	1	1	....	....	....	1	....	13
Total	18	12	7	7	6	3	2	2	2	1	1	1	1	1	64

Analysis of Species of Animals Struck.

	Cattle.	Sheep.	Horses.	Hogs.	Total.
1901	33	7	11	1	52
1902	22	47	17	3	89
1903	8	1	2	.....	11
Total	63	55	30	4	152

Analysis of Buildings Struck.

	Barns.	Other buildings.
1901	26	6
1902	39	19
1903	24	8
Total	89	33

Barns Struck.

Situation.	Date.	County.	Locality.	Nature and extent of damage.	Loss.
Four rods from row of fruit trees	Apr. 2	Kent	Harwich	Partly burned	$425
Not specified	May 26	Waterloo	.....	Destroyed with contents	Not estimtd
" "	" 28	Oxford	.....	" "	"
Trees 10 rods away	June 21	Wellington	Minto	Burned	$1,835
8 ft. from rodded barn	July 11	Wentworth	Glanford	Very slightly damaged	
Near other buildings	" 14	Lanark	Drummond	Burned	2,000
Isolated	" 20	York	Markham	Slightly damaged	15
"	" 21	Hastings	Hungerford	"	15
"	" 29	Kent	Harwich	Burned	750
A few small trees near	" 29	Peterboro	Asphodel	"	1,700
Isolated	Aug. 6	Carleton	March	"	2,150
Near poplar trees	" 6	Wentworth	Glanford	Slightly damaged	5
Near other buildings	" 11	"	"	"	
Barn was rodded	" 24	Wellington	Puslinch	Windmill on barn damaged	
Some trees near	" 24	Simcoe	Avening	Burned with crop	1,500
Not specified	Sept. 4	.....	Oxford Mills	Burned, with outbldngs, & crop	Not estimtd
" "	" 4	Ontario	Brougham	" "	"
" "	" 4	.....	Winchester	" season's crop	"
" "	" 4	Wellington	Puslinch	" "	"
Fruit trees near	" 4	Durham	Clark	" "	1,000
Isolated	" 4	Simcoe	Tecumseh	" "	1,600
Not specified	" 5	Elgin	Talbotville	" "	2,000
" "	" 5	Middlesex	.....	" "	Not estimtd
" "	" 4	Wellington	Flamboro	" "	"

Live Stock Killed.

Circumstances.	Date.	County.	Horses.	Cattle.	Sheep.	Value.
						$
Near a rail fence	May 26	Dufferin		1		40 00
In open field	July 10	Lambton		1		40 00
"	" 29	Perth		2		195 00
Under elm tree	" 29	Wentworth		2		70 00
In a stable which was struck	" 29	Peterboro	1			100 00
Under a tree	Aug. 17	"		2		70 00
	Sept. 4	Dundas	1			100 00
Near building, in field	" 9	Grey			1	5 00
Total			2	8	1	620 00

Trees Struck.

Situation.	Nature and extent of damage.	Date.	County.	Elm.	Pine.	Black ash.	Oak.	Poplar.	Willow.	Apple tree.
Single	Barked	May 18	York	1						
"	Top torn off	" 18	"		1					
"	Limb splintered	" 26	Wentworth		1					
Low, wide-spreading	Destroyed	" 26	Lambton						1	
Corner of orchard	Scorched	" 27	Grey							1
	Destroyed	June 18	Brant				1			
1½ feet apart	Barked	July 14	Lanark	2						
High tree, in a row		" 20	Simcoe	1						
" "		" 20	"		1					
Single	Slivered and barked.	Aug. 1	"	1						
High tree, at edge of bush	Split	" 8	Prescott			1				
In front of house	Destroyed	Sept. 5	Elgin					1		
Total				5	3	1	1	1	1	1

The remarkable features of these reports are, as in the previous years, the great number of barns struck and destroyed with the season's crop, and the comparative infrequency of serious loss with barns or other buildings when the buildings are rodded or adequately protected by trees. The two instances in which rods are mentioned are (1) that of a windmill on a rodded barn being struck, the windmill only being damaged; (2) that of a hay barn, separated by a space of 8 feet from another barn that was rodded. The hay barn was slightly damaged. As to trees, the writer is impelled by the evidence to repeat and to emphasize what was formerly said in the same connection, namely, that trees, and plenty of them, such trees as spruce, elm, or maple, planted near the farmstead, are a permanent and an increasing means of protection from lightning. They should be planted so that their branches, when full grown, will not touch the buildings, and yet not so far away that their protective influence is diminished. The measure of protection afforded by trees does not lie in the fact that trees are more liable to be struck than buildings, and that in the event of a storm they may be struck and the neighboring buildings saved. Such a circumstance may occur, and, in fact, often does; but a group of trees may save an adjacent building from destruction without being injured themselves. The fact is, the group, trees and buildings, are mutually protective, and very probably draw off in harmlessly small quantities the electric charge which, over the bare ground or over a single tree or building, accumulates and finally discharges with destructive violence.

II. Climatic Limits.

It is an interesting fact that at some latitude in Ontario is found the northerly limit for each of several of our most valuable agricultural and horticultural products,—such as peaches, grapes, corn, and apples. In order to find out, if possible, the position of some of these limits, this year a circular of inquiry was sent out by the Department of

Physics to a number of farmers and fruit-growers in the Province, from Essex County to the Rainy River District. About fifty replies were received, and from these replies some general conclusions have been reached upon the matter in question. In stating these results, I should like to point out some of the climatic conditions that go to determine the limits under consideration.

The Province of Ontario extends from south to north over 10 degrees of latitude,—from 42 degrees at the southern border of Essex County, to 52 degrees at the mouth of Albany River, a distance of nearly 700 miles. Within these latitudes are found wide differences of climate. Apart from the fertility and the physical condition of the soil, the elements that affect the growing and maturing of crops are climatic. The principal of these is summarized in the following table :

Stations.	Temperatures.						Months without frost. 100=complete freedom from frost.						Mean Precipitation. Rain and melted snow.	
	Latitude.	Mean Annual Lowest.	Mean Monthly Lowest.	Daily Range for March.	Mean for May.	Mean April to Sept.	May.	June.	July.	August.	Sept.	Oct.	April to Sept.	Oct. to March.
	° ′	°F	°	°	°	°							"	"
Pelee Island	41.50	— 5	19.7	9.4	57.2	63.7	80	100	100	100	100	80	17.24	14.68
London	42.59	—19	13.0	17.7	56.3	61.0	23	100	100	100	61	00	17.91	21.15
Toronto	43.40	—15	14.9	14.2	52.1	58.0	61	100	100	100	92	00	15.26	15.82
Owen Sound	44.34	—22	11.5	18.1	51.6	57.0	17	92	100	100	42	00	17.54	22.41
Gravenhurst	44.54	—33	5.1	21.7	52.7	57.4	8	92	100	100	33	00	17.21	18.37
Ottawa	46.26	—27	1.1	18.1	55.1	59.0	50	100	100	100	33	00	16.23	16.11
Haileybury	47.29	—34	—47	24.9	51.2	56.0	00	83	100	83	00	00	18.12	14.15

The suitability of any locality for growing a particular kind of produce is due not to one of these causes only, but generally to a combination of them. The meaning and extent of influence of these climatic elements will be considered under three heads: 1. Lowest temperatures. It is evident that if the winter temperature is likely to go below a certain minimum, if only once in the winter, that temperature may be destructive of trees, vines, or shrubs of the tender sort. Or if the average lowest temperature for any of the winter months is sufficiently low, then from long-continued low temperatures the trees, etc., may be killed. These two factors are expressed in columns 2 and 3 of the table :

Report on Winter-Killing.

Station.	Latitude.	Kind of fruit or grain.	Remark.
	° ′		
Smithville	43.06	Blackberries	Winter kill.
Coldstream	43.	Peaches, blackberries	Winter kill.
Mitchell	43.27	Peaches	Subject to winter-kill.
Oshawa	43.51	Winter wheat	Subject to winter-kill.
Newmarket	44.02	Strawberries	Subject to winter-kill.
Cornwall	45.02	Pears	Very few grown. Winter rather severe.
Rosetta	45.07	Plums and pears	Winter too severe.
		Winter wheat	Winter killing.
Utterson	45.10	Cherries	Trees all die first winter.
Parry Sound	45.20	Peaches	Grow three years, kill back every winter to snow-line, and finally die.
		Grapes	Have to be sheltered.
		Winter wheat	Too much snow.
Magnetawan	45.40	Red raspberries	Canes killed with frost.
		Sour cherries	Some live for few years.
Dryden	49.47	Berries, plums, cherries	Winter too severe.
		Apples	Only crabs have stood the winter.
Utterson		Apples	The hardiest varieties do well.
Orangeville	43.55	Peaches	Too severe winter.

Next to winter-killing from low temperatures, the influence of spring frosts may be considered. The damage done by a spring frost is of two sorts : (1) that known as sun-scald, (2) the killing of fruit buds and fruit sets. Sun-scald is supposed to be the result of extremes of temperature between day and night during early spring, the warmth of the sun in March being followed by a severe night frost. The liability to sun-scald, then, is expressed by the daily range of temperature at the season when such injury occurs. It may be seen from column 4 in the table that the more northerly points have a greater range of difference between day and night temperatures, and consequently fruit trees and bushes grown in the north are more liable to this form of injury. The second form of injury,—the killing of fruit buds by late frosts, depends upon the amount of advance made by the trees or plants at the time of the frost, and this in turn depends upon the mean temperature of the spring months, especially of May, when the buds begin to form and the fruit to set. A high mean temperature for May, with a liability to occasional frosts, is a very unfavorable condition for fruit. Just in this particular lies the great importance of nearness to a large body of water. The tempering influence of the water, which heats more slowly than the land, retards the advance of spring upon the land near it. A large fruit-grower at Newcastle, Ontario, whose pear orchard is within a mile or two of Lake Ontario, informed the writer last summer that five miles north of his orchard, and that distance farther from the lake, spring opened and seeding commenced a week or ten days earlier than at his farm. To this fact, the influence of the lake in retarding spring development, he attributed his unfailing success in obtaining a crop of fruit. In column 5, under Temperature, Pelee Island shows a high figure; but this point, on account of its southerly position, is safe from May or June frosts. London, Ottawa, and Gravenhurst are much less favorably situated in this particular than Toronto and Owen Sound. The exceptional success that attends fruit-growers in the Georgian Bay and Lake Ontario districts is due in large part to the slower march of spring temperatures, and hence to greater immunity from damage by spring frosts.

The shore line of Southern Ontario and the borders of the western peninsula are especially favored by the tempering influence of the great chain of lakes and rivers, from Georgian Bay to River St. Lawrence. The width of the strip along the water coming within its influence depends upon the local topography. The high ridge of land running along near the shore from Hamilton southeastward is an important factor in fixing the line between safety and danger from frosts and extremes of temperature in spring.

Spring Frosts.

Station.	Latitude.	Kind of fruit.	Remark.
Seaforth	43.32	Grapes	Late spring frosts.
Oshawa	43.51	Peaches	Late frosts ; trees grow well here, occasionally bear well.
Newmarket	44.02	Peaches	Spring frosts.
Gravenhurst	44.54	Cherries	Buds suffer from frost.
		Apples	Sun scald.
Magnetawan	45.40	Quinces	Have been tried ; frost kills every spring.
		Apples	Worst trouble appears to be sun scald.
Powassan	46.05	Cherries	Frost killed fruit sets.

The third important climatic factor is the length of the season. The factor depends upon two conditions : (1) the number of months without frost, or, more properly, the average dates of occurrence of the last spring frost and the first autumn frost ; (2) the mean temperature for the growing season. Grain, vegetables, or fruit may fail to mature from either of these two reasons, namely, shortness or coolness of the growing season.

Short Season.

Station.	Latitude.	Produce.	Remarks.
Smithville.....	43.06	Peaches.....	Season not favorable.
Seaforth.....	43.32	Tomatoes.....	Early frosts.
		Melons	Summer too cool.
Georgetown	43.39	Peaches	Fruit will not ripen.
		Grapes	" " "
Palmerston.....	43.50	Tomatoes.....	Season not long enough.
		Peaches	Have one peach tree ; fruit never ripens.
		Grapes	Do not mature.
Oshawa	43.51	Corn (grain).....	Sometimes fails to ripen.
Caledon...	43.52	Tomatoes.....	Short season.
		Corn (grain).....	Only the very early varieties mature here.
		Grapes	Not good success. Short season.
Orangeville.....	43.55	Grapes	Season too short.
		Pears	" "
Newmarket	44.02	Corn (silage).....	Failure from frosts.
		Corn (grain).....	Will not mature before frosts set in.
		Peaches.....	Season too short.
		Grapes.....	Early fall frosts.
Orillia.....	44.33	Peaches.....	Saw a few very fine ones last year grown on a local seedling, which is still alive.
Perth.....	44.53	Pears	Do not ripen early enough.
Cornwall	45.02	Corn.....	All flint varieties ripen here.
Utterson	45.10	Corn.....	A little grown for green feed ; season too short to ripen.
		Grapes.....	Vines do well, but they seldom ripen.
Parry Sound....	45.20	Melons	Season too short.
		Grapes	" "
Magnetawan....	45.40	Corn (silage).....	Will grow fairly well and reach glazed stage.
		Corn (grain).....	Have seen some well-ripened grain.
		Grapes	Vines live well, but fruit does not ripen.
Powassan.....	46.05	Niagara and Brighton grapes..	Ripen fairly well.
		Melons	Grown by some that say they have ripened them.
Dryden.....	49.47	Sugar Beets.....	Season too short.

Summary of the Reports.

Peaches. The northerly limit for peaches is about the 43rd parallel, running through Sarnia, London, and Welland. While the whole of the Niagara, Grimsby, and Winona districts is fifteen or twenty miles north of this line, these districts are favorably situated on the southern shore of Lake Ontario. Here and there north of the 43rd are certain favored spots where peaches may be grown successfully. Wherever locally, by natural or artificial means, the season is lengthened or made warmer, there the peach may be grown; but such spots are not frequent or of very large area. From many points seedlings are reported as bearing and maturing fruit, and the development by this means of a hardy variety suited to a particular locality may well deserve the attention of local horticultural societies. Guelph City and vicinity reported for the year 1902 thirty seedlings bearing, of which ten were of good quality. Clarksburg on the Georgian Bay reports that the hardier varieties are grown with good success.

Grapes. Much the same may be said of grapes as of peaches. Their home is south of the 43rd parallel. Of both these fruits, it may be said that between the 43rd and the 44th parallels, the trees and vines generally do well; but the season is on the whole too short. North of the 44th parallel the winters are rather severe, while beyond the 45th it is seldom that trees or vines survive.

In this connection the temperatures for Ottawa district are noteworthy. Although 120 miles north of Toronto, Ottawa shows a mean temperature for April to September of 59 degrees—one degree higher than that at Toronto. If the vines can be sufficiently protected during the winter and early spring, Ottawa should be able to grow grapes with considerable success.

Pears and Cherries (Sour) do well beyond the 44th parallel. Toward the 45th parallel spring frosts are frequently destructive, while beyond the 45th the trees suffer greatly from winter-killing.

Tomatoes. North of 43½ degrees tomatoes frequently suffer from early frosts.

Apples. The farther north apples can be grown the better seems to be their quality. North of the 45th parallel, however, care should be exercised in slecting varieties that will stand the winters. Winter-killing and sun-scald seem to be principal causes of injury to apple trees in the higher latitudes of the Province.

Corn is a southern plant, belonging south of the 43rd parallel, and most of the seed is grown south of this line. Some early varieties are matured as far north as the 44th. One locality (Cornwall) at the 45th reports that flint varieties will mature, but this is at the waterfront and is evidently exceptional. Corn for silage can be grown with some success, but with considerable risk of early frosts, as far north as the 45th. With this crop much depends on the soil upon which it grows. A loam or sandy loam by its warmth and excellent texture hastens the growth and maturity of the corn. Given a reasonable amount of moisture in the soil, the corn plant thrives better with plenty of heat, which should be sought in a mellow soil.

In general, it appears from the reports received that there is much misdirected and unprofitable effort made in attempting to propagate varieties unsuitable to the climates of the respective localities. The desirability of having choice fruit of various sorts in one's own garden or orchard is without question, and the attempt should be encouraged. Yet it is the part of wisdom to recognize climatic limits, and to select with care and intelligence those varieties or species that are suited to the exigencies of the local climate.

This report does not profess to be final, but is rather in some degree tentative. It is the beginning of an attempt to secure definite and exact knowledge regarding the climate of our Province and its influence upon agriculture. Not the least of our natural resources is our climate, which by its variations no less than by its general character makes possible a wide variety of produce, excelling both in quantity and quality. It is the hope of the writer that this initial report will provoke inquiry, possibly contradiction of some of its statements, with the result that the information desired will be speedily forthcoming.

III Temperature in Relation to Seed Germination.

This investigation was carried on by means of a seed germinator, consisting of an interior oven surrounded on all sides by double walls, within which water is kept. Heat applied to the base of the apparatus maintains the oven at any desired temperature, the circulation of the water distributing the heat evenly within the surrounding walls. In the oven, the seed is germinated between two concave plates laid face to face. On the lower plate a square of saturated blotting paper carries the seeds to be tested, another square of damp paper is laid over the seeds, and another plate laid face down over the whole. Fifty or one hundred seeds of one kind, according to their size and to the space available, are placed on each plate.

Per Cent. of Seed Germinated at Different Periods After Seeding.

Wheat.

No. of days after seeding.	55°—65°	68°—72°	80°	90°	95°
1					
2		6	28	8	
3	36	54	74	32	
4	82	84	82	48	
6	86	94	82	Mildew	
8	90	94	Mildew		

Corn (dent).

1					
2			6	10	28
3	6	18	66		76
4	18	70	82	82	Mildew
6	64	72	92	82	
8	74	82	92	82	

Turnip (Swede).

1			84	84	66
2	82	94	94	96	86
3	94	97	98	98	92
4	94	98	100	100	92
6	96	98			92
8	98				92

Days required for the first appearance of radicle at various temperatures.

—	45°—55°	55°—65°	68°—72°	80°	90°
Wheat		3	2	2	2
Oats		3	2	2	2
Barley		2		1	1
Pease, smooth	7	5		4	4
Pease, wrinkled	11		5	4	
Corn (dent)		3	3	2	
Turnip		2	1	1	1
Carrot	9	4	3	2	
Beet	9	5	2	2	
Parsnip		7	5	5	5
Bean	19	4	3	3	2
Clover		1		1	1
Onion	14	3		2	

Temperatures of Germination.

Species.	Best.	Second.	Third.	Remarks.
Cabbage	80	68-72	90	Vitality impaired above 80°, below 68°.
Onion	80	90		
Parsnip	80	90		Vitality destroyed at 95°.
Cauliflower	80	68-72	55-65	Vitality impaired beyond 80°.
Oats	80	68-72	55-65	Vitality impaired beyond 80°.
Beans	90	80	68-72	Mildewed at 95°.
Pease (smooth)	80	68-72	55-65	Vitality almost destroyed at 90°.
Pease (wrinkled)	68-72			
Wheat	68-72	55-65	80	Vitality impaired at 80°.
Barley	80	90	68-72	
Corn (dent)	80	90	68-72	Some mildew at 80°.
Pease (sweet)	68-72	55-65	80	Earlier germination, but impaired vitality at 80°.
Carrot	80	90	68-72	Vitality impaired beyond 90°.
Turnip (Swede)	80-90	68-72		Vitality impaired beyond 90°.
Turnip (white)	90	80	68-72	Vitality impaired beyond 90°.
Rape	90	80		
Beet (common)	80	90	68-72	
Beet (sugar)	80			
Clover (red)	90	80	68-72	Vitality impaired at 95°.
Clover (alsike)	80	68-72	90	
Radish	80	68-72		Mildewed at 90°.
Cucumber	90	80	68-72	Vitality impaired at 95°.
Tomato	90	80	68-72	Vitality impaired at 95°.
Squash	80	90		

The results of the investigations in seed germination are presented above in three forms. The first table gives the results of the count for three seeds—wheat, corn and turnips. The second shows the effect of temperature on rate of germination, The third gives a summary of the results, showing the best temperature, the second and third best, with regard to rate of germination and vitality of seed ; the last column in this table showing the effect of higher and lower temperatures in imparing the vitality of seeds

Referring now to the chart below—Mean Soil Temperatures, 1903—we find that in the first week in May the soil and air temperatures coincided at 53 degrees, the soil temperature being that observed at one foot deep. It is probable that the soil temperatures three inches and six inches deep would be but slightly higher than that at one foot deep, but only slightly. It appears, therefore, that at this period, when most of our spring grain has been sown or is being sown, the soil temperature barely reaches the best temperature for any seeds, and for most seeds is much below the best. For the last week in May the soil temperature at a depth of one foot was 57 degrees, which is over 20 degrees lower than the best temperature for corn. By June 15th the soil temperature at the same depth had reached the temperature of 58.5 degrees, which is also more than 20 degrees lower than the best for the germination of turnip seed.

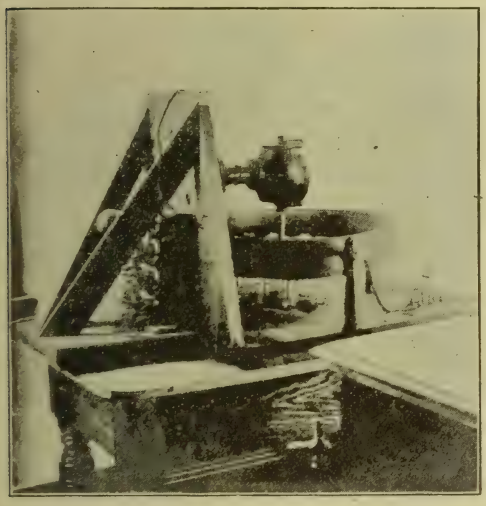


Fig. 3. Motor and centrifuge for physical analysis of soils.

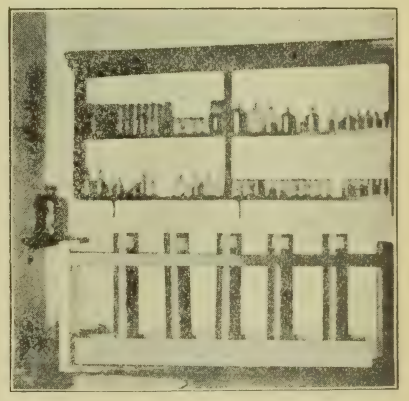


Fig. 4. Capillary tubes, for investigating the capillary capacity of soils.

These results afford fresh proof, if further proof is needed, concerning the necessity for a careful and intelligent cultivation of the soil. Heat and moisture in the soil are the prime requisites for the best success in crop growing. How to secure the right degree of each of these conditions without sacrificing the other is the great problem in cultivation. Heat is readily secured, provided the soil is dry. An excess of moisture means a loss of heat. Both conditions, however, may be secured best (1) by underdrainage, sufficient to draw off the surplus moisture, which otherwise must be removed by heat that should be used in warming the soil ; (2) by proper fall cultivation, leaving the land ridged or uneven to hasten surface drying in the spring ; (3) by early spring cultivation to separate a seed-bed from the wet subsoil, so that this seed-bed may become partially dried and warmed ; (4) by increasing the vegetable matter in the soil, which by its dark color absorbs the sun's heat.

This department will next season conduct a series of observations on soil temperatures in actual field conditions at seeding time and during the germination of the seed.

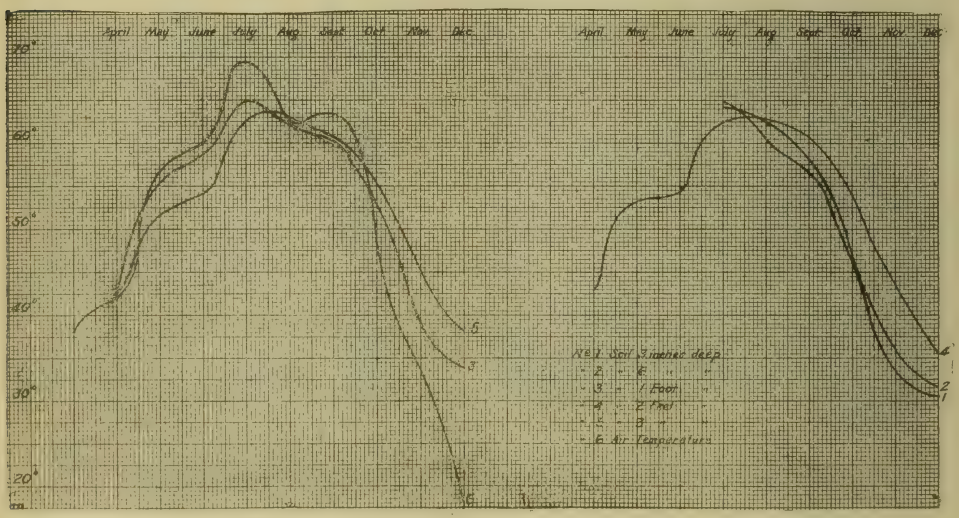
IV. Soil Temperatures at Various Depths.

These temperatures were obtained from thermometers standing in the grounds at depths of 1 foot, 2 feet, 3 feet, respectively, from April 1st until December 31st. In July two other thermometers were added at depths of 3 inches and 6 inches. It is the intention to continue these observations henceforth throughout the whole year.

The report is presented in two forms, the table and the chart :

Mean Soil Temperatures, 1903.

Month.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
April	.....	.....	41.9	43.0	42.7
May	.....	.....	55.5	53.4	51.9
June	.....	.....	58.6	54.3	54.2
July	64.7	64.3	64.9	62.5	62.6
August	60.3	61.1	62.1	62 9	63.0
September	56.4	58.1	60.5	60.9	61.1
October	46.4	46.8	53.4	54 0	55.3
November	33.4	35.8	39.0	43 6	45.3
December	30.5	31.7	33.9	35 9	38 2
	3"	6"	1'	2'	3'



Mean Soil Temperatures, 1903.

Mean daily variability of soil and air temperatures. The change of temperature from day to day, increase or decrease, known as the variability of temperature, is indicated for different depths in the ground and for the air by the following figures :

	Mean daily variability.
Air temperature	5.1° F.
Soil temperature, 3 inches below surface	3.5
Soil temperature, 6 inches below surface	2.9
Soil temperature, 1 foot below surface	1.2
Soil temperature, 2 feet below surface	0.5
Soil temperature, 3 feet below surface	0.3

V. Freezing Points of Fruit Juices.

When the experiments in cold storage were being arranged, and the temperatures of the experimental rooms decided upon, the question arose: "At what minimum temperature may the cold storage rooms be kept without freezing the fruit?" To answer the question it was necessary to determine the freezing points of the various fruits. As no accurate feasible method of doing this with the whole fruits seemed to offer itself, it was decided to use the fruit juices for the purpose. The freeing points of the fruits themselves will, if anything, be lower than those of the juices, as the tendency of solid matter in liquids is to lower the freezing point. Hence the temperature at which the juices freeze will indicate a safe minimum for the temperature of the room.

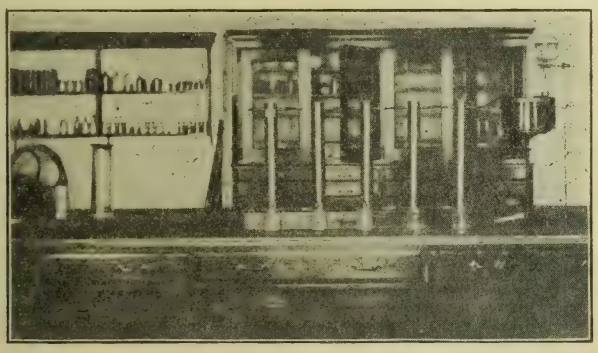


Fig. 5. Tubes for investigating the percolation of water in soils.

The method of determining was as follows: A test tube about six inches long and one-half inch in diameter was placed erect in a larger vessel and was packed about with salt and ice, approximately in the proportion of one part of salt to two of ice by weight. This produced a very active freezing mixture. A small quantity of the juice was then poured into the test tube, a thermometer was inserted, the juice constantly stirred, and the temperature watched, the tube being lifted out of the freezing mixture from time to time for this purpose and the thermometer read through the tube. The temperature continued to fall until flakes of ice had formed throughout the juice, when a stationary point was reached. At this point the temperature remained until nearly all the juice was frozen, when it again began to fall. This stationary temperature was taken as the freezing point. As a check upon the work the stationary point was watched for as the juice melted. It was found to correspond very closely with that observed during freezing.

Experiments were conducted with various varieties of apples, plums, peaches, pears, grapes and quinces. The results are given in Table 1 below. It will be seen that grapes will stand more frost than any other class of fruit tested, that pears and quinces stand next, apples third and peaches and plums fourth. It will also be observed that the freezing point of all, except Crawford peaches, is below 30 degrees Farenheit. Hence, this is a safe minimum temperature for cold storage. The results also seem to indicate that the freezing point lowers as the fruit becomes riper, but direct experiments on this point are necessary before final conclusions are reached. If this is substantiated, then, it will be possible to reduce the temperature the longer the fruit is in storage with the result of lengthening the period during which the fruit may be stored.

The specific gravities of the juices were also determined. As we should expect, the freezing point varies inversely with the specific gravity—the higher the specific gravity, the lower the freezing point.

The Freezing Points of Fruits.

Fruit.	When stored.	When tested.	Condition.		Specific gravity.	Freezing pt.	
			When stored.	When tested.		Cent.	F.
Apples.							
Astrachan	Aug. 18	Sept. 9	Rather green	Very ripe		—1.7	28.88
Snows, O.A.C	Sept. 28	Nov. 18	Firm	Firm	1.0527	—1.5	29.30
Snows, Guelph	Oct. 21	Nov. 18	Ripe	Very ripe	1.0570	—1.55	29.21
Snows, Maitland	Oct. 28	Nov. 18	Ripe	Ripe	1.0520	—1.5	29.30
Spy, O.A.C		Nov. 19	Firm, under colored	Ripe	1.0526	—1.4	29.48
Spy, Guelph	Oct. 21	Nov. 19	Firm, well colored.	Ripe	1.0534	—1.5	29.30
Average							29.3
Plums.							
Washingtons	Aug. 25	Sept. 11	Fairly ripe	Very ripe		—1.3	29.66
Bradshaws	Aug. 25	Sept. 11	Rather green	Fairly ripe		—1.2	29.84
Shipper's Pride	Aug. 25	Sept. 11	Fairly ripe	Ripe		—1.25	29.93
Average							29.8
Peaches.							
Steven's Rareripe	Sept. 23	Nov. 23	Firm	Ripe, prime	1.062	—1.5	29.3
Crawfords	Sept. 23	Nov. 23	Ripe	Ripe, prime	1.052	—1.3	29.66
Crawfords	Sept. 23	Nov. 23	Firm	Fairly ripe, fair quality	1.047	—1.1	30.02
Average							29.66
Grapes.							
Delaware	Sept. 24	Nov. 23	Ripe	Ripe, prime	1.0705	—2.3	27.86
Catawba	Oct. 30	Nov. 23	Ripe	Prime	1.0875	—3.0	26.6
Niagara	Oct. 30	Nov. 23	Ripe	Prime	1.048	—1.6	29.12
Average							27.86
Pears.							
Bartlett	Sept. 23	Nov. 23	Firm	Hard, brittle, no flavor	1.0525	—1.6	29.12
Flemish Beauty	Aug. 13	Nov. 23	Firm	Green	1.0510	—1.6	29.12
Louise Bon	Sept. 5	Nov. 23	Firm	Ripe, prime	1.0605	—2.0	28.40
Average							28.88
Quince.							
	Sept. 23	Dec. 3	Fairly ripe	Fairly ripe	1.0500	—1.6	29.12

VI. The Cold Storage Building and Experiments.

The new cold storage building described in the annual report for 1902 has enabled us this season to conduct more extensive experiments, under more controllable conditions, than in previous years. Half of the experimental section of the building is reserved for storing dairy produce, the experiments in this section being under the charge of Professor Dean. The other half is devoted to fruit storage, and these experiments are in charge of Professor Hutt and myself. The experiments this year

began with strawberries, and included raspberries, currants, early and late apples, plums, pears, grapes, peaches and quinces. It is not the intention here to give in detail any of the results obtained, since some of the fruit is still in storage. A report will likely be issued in separate form after all the species have been put out of storage.

Securing Proper Temperatures in Cold Storage Rooms.

The method of cooling the storage rooms was explained in the annual report for 1902. Briefly it consists in drawing the warm air from the rooms by a fan, driving it over pipes made very cold by expanding ammonia, and then back into the rooms. The air leaves the room by openings in a flue leading to the fan, and re-enters it by openings in another flue leading from the fan. The size of these openings is regulated by slides, and hence the rate of circulation may be increased or diminished, and the temperatures of the rooms correspodingly lowered or raised.

For our experimental purposes it was necessary to maintain one room at 30 or 31 degrees and another at 36 to 38 degrees, a difference of 6 or 7 degrees. Of the two rooms available one was exposed on two sides, the other on one only ; the latter was accordingly chosen as the more suitable for the lower temperature during the summer, when the outside air was much warmer than that in either of the rooms. But as the autumn drew on and the temperature at night fell to that required in the rooms, the days still being warm, and later when the days dropped to that temperature or below it, the nights being colder still, the summer conditions were reversed and considerable difficulty was experienced, not only in securing an even temperature, but particularly in maintaining the required difference of six or seven degrees. The difference in exposure of the two rooms was not at first looked upon as the determining factor in the problem, and efforts were made to secure the proper temperatures by running the plant during the day only or part of it ; but the results were not satisfactory. Consequently it was decided to test the effect of changing the rooms. The one formerly kept at 31 degress was now to be kept at 38 degrees, and vice versa. The fruits in the rooms were interchanged. The room now to be kept at 31 degrees is exposed on two sides, the one at 38 degrees on only one side. This proved effective, as there is a natural difference of several degrees between the temperatures of the two rooms. The plant has not been run since the change. The fluctuations of temperature were found to have been largely due to the effort to maintain at the higher temperature the room which would naturally be several degrees the colder. If, however, any slight fluctuations do occur they are easily remedied. If cooling is needed, the door leading from outside to the cooling room upstairs, where the fan is located, is left open, the cold air enters the cooling room and thence passes through the flues, into the fruit rooms below. If heat is needed, the doors into the hallway are left open, and the incandescent lights (two in each room) are turned on. The hall being situated in the centre of the building, and hence being unexposed, is about two degrees warmer than the cold room, while the lamps will raise the temperature about two degrees. While for three days in succession the outside air was below zero, the thermometer registered -17.5 on the 1st, -25 degrees on the 2nd, and -24 degrees on the 3rd, the temperature in the colder room did not fall below 29 degrees, which from Table 1 is seen to be just on the danger line. None of the fruit, however, was frozen at this temperature. This severe test demonstrated two facts : first, that the insulation is well-night perfect, and, second, that we are able, despite the greatest extremes of cold, to maintain throughout the winter almost uniform temperatures of 30 or 31 degrees, and 36 to 38 degrees in the two rooms respectively with practically no artificial heating.

VII. Weather Report, 1903. At O. A. C., Guelph.

—	Jan.	Feb.	Mar.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Mean temperatures.....	18.7	21.0	38.2	42.2	56.6	60.1	69.5	62.5	63.1	48.6	34.5	18.1	44.4
Dep'ture from normal	-0.6	+3.8	+9.5	-1.0	+2.0	-2.2	-0.1	-3.9	+2.4	-0.5	-0.9	-4.0	+0.7
Lowest temperatures...	-6.0	-8.5	10.8	8.7	25.0	43.0	43.0	41.0	29.0	24.0	-2.0	-9.0	-9.0
Highest temperatures...	46.0	45.0	73.0	77.0	84.0	82.0	90.0	81.0	83.0	74.0	66.0	42.0	90.0
Precipitation in inches (rain and melt'd snow)	2.03	0.72	0.22	2.69	2.44	3.05	2.67	3.47	1.48	2.78	0.75	1.25	23.53
Dep'ture from normal.....	+0.38	-0.85	-1.05	+0.75	+0.14	+0.30	-0.90	+1.44	-1.01	-0.49	-0.88	-0.25	-2.42

Weather Report.

Year.	Date of last frost in spring.	Date of first frost in autumn.	Length of period without frost.
1899.....	May 15	September 23	130 days.
1900.....	May 10	October 17.....	158 days.
1901.....	May 15	October 4	141 days.
1902	May 11	October 2	143 days.
1903.....	May 5	September 29	146 days.
Average	May 11	October 3	144 days.

Respectfully submitted,

J. B. REYNOLDS,

Professor of Physics.

PART IV.

THE PROFESSOR OF BIOLOGY AND GEOLOGY.

To the President of the Ontario Agricultural College :

Sir,—I have the honor of presenting herewith my Sixth Annual Report on the work done in the Biological Department for 1903.

The duties of this department fall naturally under three heads : 1, Instruction ; 2, Outside work, including correspondence and the writing of special articles for the press ; and, 3, Investigations regarding weeds, fungous diseases, and insects.

I. Instruction.

The work of instruction, of necessity, occupied the larger portion of the time of the staff of this department. With the increased accommodation furnished by the new class rooms and laboratories, more attention was given this year to the practical aspects of Biology, especially in their relation to Horticulture and Agriculture. By means of excursions the students became familiar with the habits and appearance of the weeds, fungi, and insects which do so much damage to farm, orchard, and garden crops; and by a laboratory study of their own and the department collections, they learned more intimately the structure and life-history of the plants and insects which were brought to their attentions, and much to accurate drawings of the objects studied. Moreover, the students were encouraged to continue their observations during the summer, at their homes on the farm, and were asked to report to this department the insect-pests and fungous diseases which were working injuriously on the crops. By these means we hope to have the young men leaving college not only good farmers, but also keen observers and accurate reporters of the farm conditions in their respective districts.

Following is a brief synopsis of the regular courses given in 1903 in Botany, Entomology, Zoology, and Geology :

Botany, First Year. (a) Field excurisons, where the student familiarizes himself with the names of the common wild plants, learns their manner of growth, and the ways the fruit and seeds are produced and disseminated ; (b) Laboratory studies of the entire plant, including root, stem, leaves, and fruit ; and (c) Lectures summarizing and illustrating the practical work.—By Mr. Hotson.

Botany, Second Year. (a) Field excursions and laboratory studies in the morphology of plants, especially those parts of economic importance, and their classification ; a critical study of weed-seeds, and an elementary course in the study of grasses and fungi ; (b) Lectures (two every week) on the morphology, classification, and physiology of plants.—By Mr. Lochhead and Mr. Jarvis.

Botany, Third Year. (a) Laboratory and lecture courses in systematic botany, including grasses—by Mr. Lochhead and Mr. Jarvis ; (b) Laboratory and lecture courses in Structural Botany—by Mr. Hotson ; (c) Lecture and laboratory courses in plant physiology—by Mr. Lochhead and Mr. Jarvis.

Botany, Fourth Year. Specialists in Biology and Horticulture. (a) Laboratory and lecture course in plant histology—by Mr. Henderson and Mr. Hotson ; (b) Laboratory course in fungi and plant pathology—by Mr. Lochhead and Mr. Jarvis ; (c) Seminary and practical course in plant physiology—by Mr. Lochhead.

Botany, Fourth year. Specialists in Agriculture and Biology. (a) Laboratory course in systematic botany—by Mr. Lochhead ; (b) Lecture and laboratory course in grasses and forage crops—by Mr. Lochhead and Mr. Jarivs.

Botany, Fourth Year. Specialists in Horticulture. (a) A laboratory course in the study of cultivated plants—by Mr. Lochhead.

Entomology, Second Year. A course of thirty-five lectures, demonstrations and practical exercises. The chief insect pests of the farm, orchard, and garden are discussed and studied, under Mr. Lochhead and Mr. Jarivs.

Entomology, Third and Fourth Years. This course, consisting of lectures and practicals, deals with both beneficial and injurious insects, and is a continuation of the second year course. Here the students become acquainted with the literature of the subject.—By Mr. Lochhead and Mr. Jarvis.

Zoology, First Year. This course consisted of lectures and practicals, thirty in all. The chief animal types from the Amoeba to Mammals are discussed, and much attention was given to the Birds and Mammals of the farm—by Mr. Henderson and Mr. Jarvis.

Zoology, Fourth Year. Specialists in Biology. A lecture and laboratory course—by Mr. Henderson.

Geology, First Year. A course of thirty lectures and demonstrations, dealing with the common minerals and rocks, the chief agencies operating in the formation of soils, and the geological history of the rock formation of Ontario—by Mr. Lochhead and Mr. Jarvis.

Geology, Third Year. This course is a continuation of the first year course; but it is of a more practical nature, because the class is smaller. Considerable attention is given to the formation of soils through glacial action; and the geological history of North America is studied with special emphasis on the Canadian region—by Mr. Lochhead.

I take pleasure in placing on record my appreciation of the valuable assistance rendered by my co-workers in this department. Mr. A. Henderson, B.A., resigned in September to resume his medical studies in Toronto, but we were fortunate in securing the services of Mr. J. W. Hotson, M.A., of McMaster University, an experienced teacher and a good botanist. Mr. T. D. Jarvis, B.S.A., Demonstrator, has been of great service in conducting the laboratory exercises in Entomology and Plant Pathology, and in arranging the department's collections of insects and plants.

The Herbarium and Insect Collections.

A good beginning has been made in arranging the mounted plants, but much requires to be done before the plant collections can be used to advantage by the students for the purpose of reference. Our collection of cryptogamic plants are still meagre in many regards. Our ferns, horse-tails, and club-mosses are fairly well represented; we have an incomplete assortment of fungi, and the Tilden collection of algae; but the mosses and liverworts are almost unrepresented.

Now that we know the weaknesses of our collections, it will be much easier to fill in the gaps.

We desire to thank the editor of the Farming World for donating several small but valuable collections of mounted flowering plants, as each was collected in a different part of the country.

Our insect collections are gradually growing, but we have not yet a reference collection of Diptera, Hymenoptera, or Coleoptera worthy of the name. In the absence of such a reference we, as well as the students, are often unable to identify with certainty many forms which are brought to our attention. Mr. T. D. Jarvis has spent much time in the collection of material for class work in Entomology, so that now we have specimens of most of the common and economic insects to give every student in laboratory work.

The Needs of This Department.

Although many of the urgent wants of this department have been supplied, yet there are still some very pressing needs. In an agricultural college such as ours,

practical instruction should be emphasized, and it is as true of the Biological studies as it is of the Agricultural or Horticultural.

We are now well equipped with class rooms and laboratories for the study of many phases of plant and animal life, but there is still lacking a greenhouse for experimental plant physiology, and for the study of the life-history of the insects. Without such a building, the most important phases of plant and insect life must be left untouched.

We need also many additions to our meagre supply of apparatus for experimentation in plant physiology.

Our needs are, therefore :

1. A greenhouse to serve as an insectary and a laboratory of plant physiology.
2. Additional apparatus for a class of 35 in plant physiology.
3. Five or six additional microscopes.
4. A more complete reference collection of insects.

Outside Work.

Through the kindness of the Minister of Agriculture and yourself, I was privileged in March to visit some of the schools of New York and New England which were devoting considerable attention to Nature Study. I spent three days at Cornell University, where I discussed Nature Study problems with the officers of the College of Agriculture and with "Uncle John" Spencer. At the Teachers' College of Columbia University, New York City, I learned a great deal regarding the teaching of Nature Study in a practical way in the Horace Mann School attached to the Teachers' College. In Hartford, Connecticut, I had the privilege of seeing school-garden work done by the school children of that city, under the superintendence of Prof. Hemenway of the School of Horticulture. At Worcester, Massachusetts, I spent a very pleasant day with Prof. C. F. Hodge, who is an enthusiastic advocate of Nature Study in public schools.

In connection with the local movement for a consolidated school, I visited four of the sections in this vicinity early in the winter, and addressed the ratepayers on the advantages of a consolidated school system, basing my remarks on the observations I had made while on a visit with Prof. Robertson to the consolidated schools of Trumbull County, Ohio.

On September 3rd and 4th the annual meeting of the Entomological Society of Ontario was held in Ottawa. I presented the following papers : "Insects of the Season of 1903," and "The Present Condition of the San Jose Scale in Ontario," and I delivered the President's address, taking for my subject "The Progress of Economic Entomology in Ontario." I had the honor of being re-elected President for the coming year.

Under instructions from the Deputy Minister of Agriculture, I visited the Kottmeier orchard, St. Catharines, four times during the summer, to ascertain the effectiveness of the McBain Carbolic Wash against the San Jose Scale.

Acting also under instructions from the Deputy Minister of Agriculture, I paid several visits to Barrie on matters pertaining to the removal of barberry shrubs and the compensation of the owners for the destruction of their shrubs.

A hurried visit was made in August to the fruit sections of Kent and Essex for the purpose of studying the conditions of the orchards and the injuries done by insects and fungi.

Correspondence and Articles Contributed to the Press

As usual, the correspondence has been somewhat heavy during the year, more than one thousand letters having been sent out. The bulk of this correspondence had to deal with the common farm pests, such as weeds, insects, and fungous diseases. The following articles were contributed to the agricultural journals and papers :

"Scale Insects in Greenhouses," for the Canadian Horticulturist, February.

"School Gardens," for the Canadian Horticulturist, July.

"The Twig Blight of the Apple, Pear, and Quince," for the Canadian Horticulturist, August.

"The New Gooseberry Fruit Worm," for the Canadian Horticulturist, August.

"Tree Protectors," for the Canadian Horticulturist, August.

"The Spruce Gall Louse," for the Canadian Horticulturist.

"The Cottony Maple Scale," for the Canadian Horticulturist.

"Consolidated Schools," for the Farmers' Advocate, April 15th.

"Nature Study With Advanced Classes," for the Ottawa Naturalist, October.

"Nature Study," for the O.A.C. Review, February.

"The Twig Blight of the Pear," for the Weekly Sun.

"Nature Study and Country Life," for the Xmas O.A.C. Review.

Bulletins Published

The following bulletins from this department were published during the year:

"Peas and the Pea Weevil," in co-operation with Mr. Zavitz.

"The Weeds of Ontario," a revision of the bulletin entitled "Weeds of Ontario," prepared by Prof. Harrison and published in 1899.

Nature Study Class.

For the first time in the history of the College, the third year students devoted two additional months, from April 15th to June 15th, entirely to Nature Study. This was a new departure, but I do not hesitate to say that the results justify the departure. In this work I was aided by Messrs. Henderson and Jarvis of this department, and by Mr. T. Otway Page, B.A., of Guelph. The latter gentleman, who is well acquainted with birds, had charge of the excursions in bird study. More than sixty birds were recognized by the students and their habits noted. The studies made by the students covered a great many subjects. As far as possible no aid was given beyond some general directions. Careful drawings were required of every student, as well as a report on some nature topic at the end of the term. Each student was required also to give a popular address before the class upon some topic which he had studied.

Prof. J. W. Robertson did us the honor to send ten of the MacDonald teachers in training for instruction in Nature Study. These gentlemen devoted most of their time to birds, field excursions, and garden work. No formal lectures were given by the regular instructors, but the class had the pleasure of listening to two admirable lectures on certain aspects of Nature Study by Prof. Lloyd of the Teachers' College, Columbia University, New York. It was my aim throughout to make the students investigators, and to get them into full sympathy with their surroundings. I feel that the course was a valuable one for the students, and that it should be made a permanent feature of the College.

The Museum.

Little has been done towards the fitting up of the Museum since my last report was written, on account of the want of suitable cases in which to display the specimens. We hope, however, to be able soon to place some of the birds and rocks in the few new cases purchased by means of an appropriation made at the last session of the Legislature. An extra appropriation for the additional cases and cabinets will be asked for from the next Legislature.

The following collections were added to the Museum during the year:

1. The Hon. G. W. Allan Collection of Birds, 258 specimens, especially strong in aquatic forms.

2. The A. Gibson Collection of Lepidoptera, comprising nearly 2,000 specimens.

3. A collection of Pacific Coast Fishes from New Westminster, B.C., generously sent by T. F. Patterson, B.S.A., formerly Fellow in Biology at this College.

4. A small collection of specimens of Gold Ore from the Woodstock Mining Company's mines, Guysboro' County, Nova Scotia, presented by B. E. Patterson, B.S.A.

5. The skin of a rattlesnake, presented by Captain MacMaster, Department of Agriculture, Toronto.

6. The Thomas Otway-Page Collection of Birds' Nests and Eggs, donated by T. Otway-Page, B.A. This is a most valuable collection of the nests and eggs of our native birds, collected with great care, and with greater patience, by the donor. In connection with this donation is a series of colored drawings of the birds, made by Miss Holliday, Guelph. For purposes of reference and Nature-study, it is one of the most valuable collections in the Museum.

A liberal annual appropriation for the purchase of desirable collections and specimens is urgently needed to make the Museum an educational factor in college work and a place of interest for our many visitors.

Mustard Spraying.

In 1901 and 1902 Mr. M. W. Doherty, late Associate-Professor in this department, gave valuable demonstrations at many points in the districts badly infested with mustard. The reports of these demonstrations are to be found in the annual reports of the Ontario Agricultural College for those years.

Fig. 1. A demonstration in mustard spraying at Markham on the farm of Reuben Lunau. June 16, 1903.

In 1903, at the request of the Minister of Agriculture, this department undertook to give practical demonstrations in killing mustard by spraying with bluestone in some of the districts infested with wild mustard. Mr. F. W. Brodrick, B.S.A., had charge of the demonstrations in the counties along Lake Ontario east of Toronto, and Mr. D. H. Galbraith, B.S.A., those in the central counties, viz., York, Ontario, Simcoe, Peel, and Dufferin. Through the courtesy of the Spramotor Co., of London, they were supplied with complete spraying outfits.

Printed copies of the following circular were distributed freely among the farmers who witnessed the demonstrations.

Killing Mustard with Bluestone.

(Read carefully and preserve for reference.)

The demonstrations given throughout Ontario for the destruction of wild mustard have proved that, in the majority of cases, under favorable conditions, spraying with copper-sulphate almost entirely eradicates this troublesome weed from growing cereal crops.

I. How the Bluestone is Applied:—Place an ordinary spray pump, to which is attached the 6-row sprayer, on a cart or light wagon; drive along slowly through the field, applying the solution to the mustard plants in the form of a fine spray. When the field is badly infested, it is advisable to spray the crop in strips in order that no mustard plants may escape the spray.

II. How the Bluestone Solution is Made:—Put nine (9) pounds of Bluestone (Copper Sulphate) in a coarse sack or bag, and suspend it in a vessel containing three (3) gallons of very hot or boiling water. The Bluestone will usually dissolve in 15 or 20 minutes. Strain the solution into the barrel of the spray-pump, and fill up with cold water to make 40 or 45 gallons.

III. When to Spray the Mustard Plants:—Spray the Mustard on a calm, bright day, just as the plants are coming into bloom. Should a heavy rain come immediately after spraying, it will be necessary to spray again.

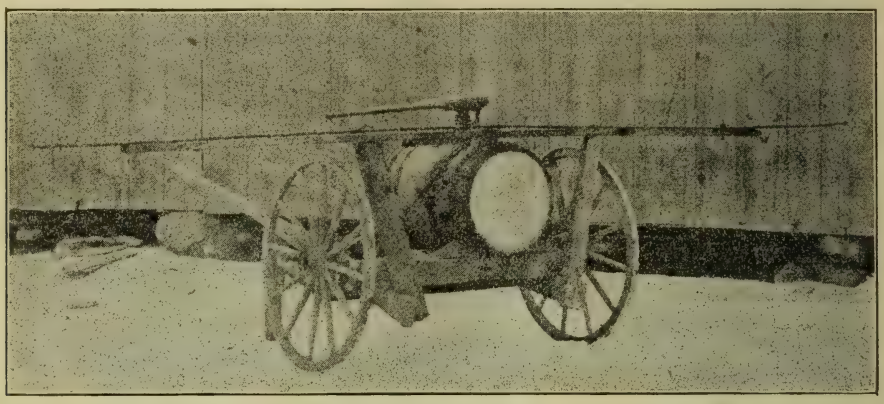


Fig. 2. A spraying outfit arranged by Thos. Thomson, Headford.

IV. How Much is Required to Spray an Acre Thoroughly?—A barrel of the solution, costing about eighty or ninety cents, is sufficient for an acre. Successful results are obtained when the spraying is done thoroughly.

V. Are the Crops in Which Mustard is Growing Hurt by the Spray?—Experience shows that young wheat, barley, oats, or clover plants are not injured, beyond a slight browning for a few days by the Bluestone spray.

For further information write to The Biological Department, Ontario Agricultural College.

Guelph, June, 1903.

The demonstrations were not uniformly successful, but it was shown that the failures were mainly due to rain soon after the spraying operations. In every case reported to us, when rain did not fall for 36 or 48 hours after spraying, the operating was completely successful; but when rain fell within a few hours after the demonstration a certain percentage of the mustard plants was not killed. The demonstrations proved also the value of early spraying, for the best results were secured in every case when spraying was done just when the plants were coming into bloom.

Following are the dates and places of the demonstrations given by Mr. Brodrick, and a few of the reports received:

June 8.—I. Langmaid's, near Whitby. Mustard partly in bloom and too far advanced; oat crop 10 to 12 inches high.

Report of Committee re Spraying on Isaac Langmaid's Farm.—"The mustard plants were too far advanced. However, nearly every plant was killed inside of a few days. A few of the oldest plants lived some time, but matured few or no seeds. A slight browning of the grain crop took place. At first the leaves of the thistles and wild buckwheat turned decidedly brown, but they were not killed. There was no apparent injury to the crop of grain or to the clover. The demonstration showed conclusively that when properly done under favorable conditions the mustard can be killed by spraying with copper sulphate. (Signed) Isaac Langmaid, James Langmaid, Elmer Lick."

June 9.—Wm. Banks, near Pickering: A little rain fell in the afternoon; oat crop 6 to 7 inches high; mustard in bloom and rather far advanced.

June 10.—Wm. Tordiff, near Brooklin: Day cold but clear; oat crop about 10 to 12 inches high; mustard nearly all in bloom.

June 11.—T. Wright, of Scarboro': Weather threatening and plants wet; oat crop about 9 inches high; mustard thick and coming into bloom.

Mr. Wright's report: "July 16th, 1903. I am sorry to say that the bluestone did not destroy it all. My opinion is that if it was done a little earlier and in favorable weather it might have succeeded, for where the mustard was not so old it was killed. Thos. Wright."

June 13.—A. E. Bellman, Bowmanville: Weather clear, but it had been raining the previous night; mustard well advanced.

Mr. Bellman's report: "Bowmanville, July 24, 1903. It rained several showers that day before spraying, and also about 24 hours after. We tried spraying in two different pieces of grain in which the mustard was in two different stages of maturity—one in which the mustard was fully out in bloom, and the other piece only partially out. It seemed to have killed both pieces to about the same extent. I would think about 90 or 95 per cent. was killed. It seems to be a very particular job, to get it applied properly. The applying of it is one of the most important part of the business, for if a nozzle gets choked, or you drive a little too far away, or, in fact, if you do not get it on in sufficient quantities, most likely you will not detect it at the time of spraying, but in three or four days you will have no trouble in seeing every slip or failure. There is no doubt that it will kill the mustard if you get it on in sufficient quantities. The mixture does slightly burn the grain when applied. A. E. Bellman."

June 15.—J. S. Walker, Welcome, near Port Hope: Weather fine; oats 10 inches high; mustard higher and in bloom; a little too far advanced.

June 16.—Edwin Macklin, Cobourg: Weather clear and warm but threatening; oats 10 inches high; mustard in bloom and too far advanced; rained following night.

Mr. Macklin's report: "Cobourg, Aug. 11th. The spraying which Mr. Brodrick did for us we considered a success. Had it not been for the heavy rain which fell about six hours after the work was done, I think it would have been killed completely. As it was, I think, as near as I could judge, about 85 per cent. was killed, or possibly a little more than that. The tips of leaves of goose wheat, the crop sprayed, were just slightly browned, but it soon passed off, so I would say the wheat was not injured. It did not have the slightest effect on wild vetches or tares. The grain, as well as the yellow weed, was very large when sprayed. Ernest E. Macklin."

June 17.—J. L. Grosjean, Grafton: Dry and cloudy and rather cold; oats about 12 inches high; mustard higher and too far advanced.

June 18.—P. W. Brown, Colborne: Day wet but clearing; mustard in good stage for spraying.

June 20.—H. Herrington, Brighton: Day cool and cloudy; began to rain about 7 p.m.; mustard coming into bloom.

June 22.—G. A. White, Trenton: Day fine and clear; both wheat and oat crops treated; mustard too far advanced.

Following are the dates and places of demonstrations given by Mr. Galbraith:

June 10.—Jas. McNaughton, Gourock: rain fell the night following; not a success.

June 11.—W. Lewis, Malton.

June 13.—S. M. Kennedy, Uxbridge.

June 15.—S. Ross, Ellis' School; R. Sproule, Cannington.

June 16.—R. Lunane, Markham.

June 17.—P. Christie, Manchester.

June 20.—R. Stewart, Badford.

June 22 and July 2.—W. Rintoul, Whittington.

June 25 and 26.—J. Ross, Simcoe County Farm, Beeton.

Mr. Munro's report: "Port Perry, Dec. 24th, 1903. Last year we sowed early peas in the field that we sprayed this year, and the mustard nearly choked them out. This year it was worse if possible. We had barley sown in the place of peas. In a few days after spraying you could not see any mustard a short distance off. Our crop of barley yielded about 30 bushels. I think the spraying is a benefit to the crop, as we sprayed a small piece first, and it was the heaviest barley in the field. John Munro."

Mr. Christie's report: "Manchester, Jan. 2nd, 1904. I may say that we had no chance to make a test, as it rained nearly all day, and Mr. Galbraith had to leave the next morning for some other point. We mixed a small quantity and applied it with our orchard sprayer on some barley, and it killed the mustard without any damage to the barley. I am satisfied the mixture is all right. Peter Christie."

Mr. Rintoul's report: "Whittington, Dec. 24th, 1903. Regarding the report of the work done by Mr. Galbraith, we cannot speak definitely, as the climatic conditions were against us at both of the trials. The first trial was scarcely finished an hour when it commenced to rain, thus washing the solution off the plants; still the effects were easily noticed. The mustard plants were all covered with little dead yellow spots, but not sufficient of them to kill the plants. At the next demonstration the plants were all flowered out, and the solution was on about four hours when it came on rain; quite a number of the smaller plants were killed, but the large and healthy ones did not seem to be much harmed. The thistles were all blackened and wilted. The blades of the grain were yellow, but they were not injured. As far as I could judge, I think it would be a success in destroying the mustard plant. W. Rintoul."

Experiments With Other Chemicals.—As good results were secured in 1902 in Wilts County, England, by using commercial muriate of potash and nitrate of soda in the eradication of mustard, it was thought advisable to determine the value of these chemicals when applied on mustard in Ontario. Although the experiments were not conclusive, yet the results show that with further experimentation something of value may be obtained.

Experiment No. 1.: Sprayed June 20th an acre of mustard with a solution composed of 2 per cent. copper sulphate and 6 3-4 per cent. murriate of potash. The mustard was well advanced, but no rain fell for several days following the application. The mustard was entirely killed. The leaves began to wilt within 24 hours after spraying.

Experiment No. 2: Sprayed a small plot with a mixture composed of 2 per cent. copper sulphate and 11 per cent. muriate of potash. Rain fell three hours after spraying. Excellent results were secured. The leaves of the mustard plant began to wilt within a few hours after treatment.

Experiment No. 3: Sprayed a small plot with a solution composed of 2 per cent. copper sulphate and 11 per cent. nitrate of soda. Good results were obtained. The mustard was killed, but not so quickly as in experiment No. 2.

Experiment No. 4: Sprayed a small plot with a solution composed of 5½ per cent. muriate of potash and 5½ per cent. nitrate of soda. Only a small percentage of the mustard plants were killed. In this experiment, rain fell within three hours after spraying.

Experiment No. 5: Sprayed a small plot with a 22 per cent. solution muriate of potash. Rain fell within three hours after spraying, and but few mustard plants were killed. It may be stated that the use of these chemicals increases the cost of the application about three times, or about $2.50 per barrel.

Three New Weeds.

Within recent years, and since the opening of the great west, many western plants have been introduced into Ontario through the use of western grain and forage seeds. With the cultivated plants have come also some of the western weeds; among which

are the Russian Thistle, Great Ragweed, Buffalo Bur, Wild Barley, Rosin plant, Prickly Lettuce, Bracted Plantain, and others. Of these, we may now speak of Wild Barley, Rosin Plant, and Bracted Plantain.

Fig. 3. Squirrel Tail or Wild Barley (*Hordeum jubatum*). A single cluster of plants. (Photo. by Charlotte M. King.)

1. Wild Barley (Hordeum jubatum. Fig. 3), is characteristically a weed of the meadows and pastures, and of the prairies of the Mississippi valley. It is a winter annual, and grows to a height of two feet; but commonly it is not more than eight or nine inches in height. The roots are fibrous, and make a well formed sod. It stools very freely, and forms solid and compact bunches, each of which may produce from 300 to 2,000 mature seeds. The flowers are arranged in spikes from two to four inches long,

and resemble heads of common barley The seeds are scattered by the wind and by animals. They often cause much injury to stock.

Cultivated land is seldom injured by Wild Barley. When it occurs in pastures and meadows, the grass should be cut young and not allowed to seed. If this precaution is taken for a few seasons, the Wild Barley will soon disappear.

Wild Barley is a pernicious pest in Manitoulin Island, and in the upper lake region.

2. Rosin Plant (Grindelia squarrosa), is also a native of the prairie region. It resembles a sunflower which has received a coating of glue or some other sticky substance.

This weed is very common west of the Mississippi, and is gradually extending eastward. In Colorado, where it has been known for a long time, it invades cultivated fields, and locally is very troublesome in corn land. It is also rapidly spreading into fields and upland meadows in Manitoba.

Figure 4 shows one of the "seeds," or achenes, of the Rosin Plant. The seed is about 1-10 of an inch in length, somewhat flattened, and four-angled; somewhat narrowed at the base, where there is a distinct white scar; the color is light brown to cream.

3. Bracted Plantain (Plantago aristata) is one of the newest weed arrivals in Ontario, so far as I am aware. Specimens were sent me from Kent. It resembles to a limited extent the narrow-leafed plantain, or rib-grass, which is so common with us. The main difference is in the spike of flowers. In the Bracted Plantain, the flowers of the spike are subtended or intermingled with bracts or short narrow leaves. The seeds are dark-brown, one being shown in Figure 5. They are about 1-12 of an inch long, and rounded on the ends. The rounded outer face is marked by a shallow transverse groove near the middle; and the inner face is grooved, with a scar near the middle.

Fig. 4. Seed of Rosin Plant.

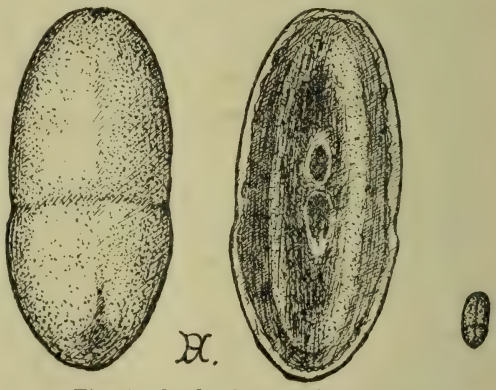


Fig. 5. Seeds of Bracted Plantain.

As this plant is a winter annual or a biennial, fall cultivation and care in sowing clean seed will keep it in check, if it ever becomes a serious pest.

Egyptian-Pea Blight.

An interesting, and at the same time a very destructive blight fell upon the plots of Egyptian Peas in the Experimental Grounds of the College during the summer. On August 8th, when I visited the plots, practically all of the Egyptian Peas (Cicer arietinum) were diseased, and the survivors of the epidemic were few in number. Pods had formed on many of the plants; but the seeds within were shrivelled and undeveloped. The disease affected the stems and leaves as well as the pods. Fig. 6 shows the appearance of an affected pod. The spots are brown and dry; they are roundish to oval and irregular in outline; and many of the spots have rings of black specks, more or less concen-

tric. When examined under a low power of microscope, each speck when isolated is of a dark-brown color, is hemispherical in shape, and has an opening or mouth at the apex.

These hemispherical, brown bodies are the fruit-bodies, termed pycnidia, and they

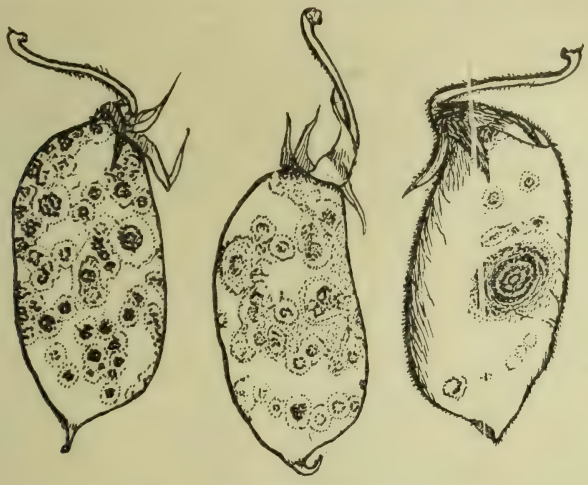


Fig. 6. Egyptian Pea Blight. The characteristic spots on the pods × 2. (Original.)

contain the spores by means of which the disease is spread to other plants. Each pycnidium is composed of a dark-brown wall, formed of sterile threads of the fungus; and from the inner sides project the stalks bearing the spores. (Fig. 7).

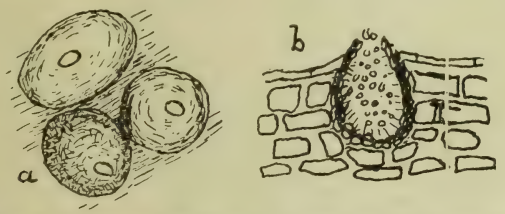


Fig. 7. (*a*) The pycnidia of Egyptian Pea Blight; (*b*) section of a pycnidium showing how it is imbedded in the tissue of pod; greatly magnified. (Original.)

The spores are transparent and colorless, oblong in shape, and mostly one-celled at the time the diseased specimens were collected. Only a few spores were two-celled. The dimensions of the spores ranged from 12 to 16 microns long by 4 to 6 microns wide. At maturity, the spores are extruded through the mouth of the pycnidium in long viscid tendrils. On exposure to air, the mucilage dries and the spores are set free. The pycnidia are 130 to 160 microns in diameter.

The fruiting characters of this fungus resemble both Phyllossticta and Ascochyta. The unicellular spores are like those of Phyllosticta; but the diameter of the pycnidia and the parts of the plant affected would make it Ascochyta. It is very probable that the spores were immature when the specimens were collected; if so, then I would be inclined to believe that the fungus which destroyed the Egyptian Peas of the experimental plots is Ascochyta pisi, a common blight of the cultivated pea (Pisum arvense).

The Raspberry Cane-Blight

Early in August, I was asked by Prof. F. C. Stewart, Botanist of the Geneva Agricultural Experiment Station, to report as to the presence of the Raspberry Cane-Blight in the College raspberry plantation. On August 10th, I examined the plots and found

many of the fruiting young canes attacked by fungus. Besides the anthracnose spots, which are well known, there were light-colored areas marked with black specks, and dark-colored regions where the bark was broken, and the wood brown and brittle. The light-colored areas are produced by a fungus called Sphaerella ; and it appears that it

Fig. 8. Raspberry Cane Blight on Pride of Geneva.

The fungus attacked and killed the cane at the point indicated by the arrow. As a consequence, all foliage above this point withered. (After Stewart.)

does but little damage to the canes. Much harm, however, is done by the fungus which produces the dark brittle areas. We found in the College plantation, after examination, that considerable harm had already been done. In some cases, the leaves on the affected canes were dead and withered, while in others but few leaves were involved. It was not possible at that date to make out the manner of inoculation and spread; but Prof. Stewart, of Geneva, who has devoted considerable time to the study of this disease in New York where much harm has been done during the last three or four years, describes the working of the fungus as follows:

Fig. 9. The spores of the Raspberry Cane Blight (*Coniothyrium*), greatly maguified. (After Stewart.)

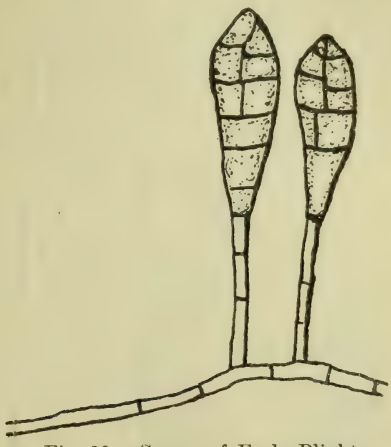


Fig. 11. Spores of Early Blight; greatly magnified. (Original.)

"With black caps the disease frequently starts in the old stub left in pruning. From this point it gradually works downward, killing first the uppermost branch, then the next lower one, and so on until by the close of the berry harvest one-half or more of the cane may be dead. On black caps, the disease also shows a tendency to work down one side of the cane, killing the bark and discoloring the wood on that side, while on the other side the bark remains green. This may occasionally happen with the red varieties, but as a rule they are attacked at some particular point on the cane. Here the bark is dead and the wood brown. For some time the injury extends only part way round the cane, and as long as there is a strip of green bark left connecting the parts above the point of attack with those below all goes well; but when the injury at length completely encircles the cane the leaves on the portion above the injury suddenly wilt and die. (Fig. 8.) By the time this happens, the cane at the point of attack is dead throughout a section which is usually from two to four inches in length. Both above and below this dead section the cane itself may be normal, with nothing to indicate the cause of the sudden wilting of the leaves. However, a cane may bear several of these dead sections of various sizes. If the point of attack is near the ground the whole cane dies; if higher up, only a part of it. When part of a cane dies while the remainder continues alive, the point of attack is to be sought at the boundary between the dead and living portions. Usually, the seat of the difficulty may be located by the color of the bark, which is somewhat different from that on the rest of the cane. For the most part it is lighter colored and smutty, with smoke-colored patches of exuded spores. (Fig. 9.) In many cases numerous minute pimples, the pycnidia of the fungus, are visible. By cutting into the cane with a knife the matter may be decided at once. Where the cane is diseased the wood is strongly discolored. A marked charcteristic of cane blight is the brittleness of the cane at the point of atttack." (Bulletin 226, N.Y. Ag. Exp. St., Geneva.)

Remedial Treatment · Professor Stewart, of Geneva, writes me that it seems improbable that the disease can be prevented by spraying. In 1902, he sprayed infested Cuthbert raspberries three times, during the spring, with Bordeaux Mixture. "From ob-

servations made on August 2nd, it was plain that spraying did not check the disease. Apparently, there were as many dead canes in the sprayed rows as there were in the unsprayed ones." His experiments in 1903 on spraying with Bordeaux Mixture have given practically the same results as were obtained in 1902. He recommends that the following precautions be observed : (1) To secure healthy plants with which to start the plantation ; (2) To remove the old canes immediately after the fruit is gathered.

The Two Blights of Potatoes.

The Early Blight of potatoes is frequently mistaken for the Late Blight, or potato rot ; but the two diseases are in reality quite distinct and are caused by different fungi. There are a few characteristic differences which readily distinguish the two potato blights.

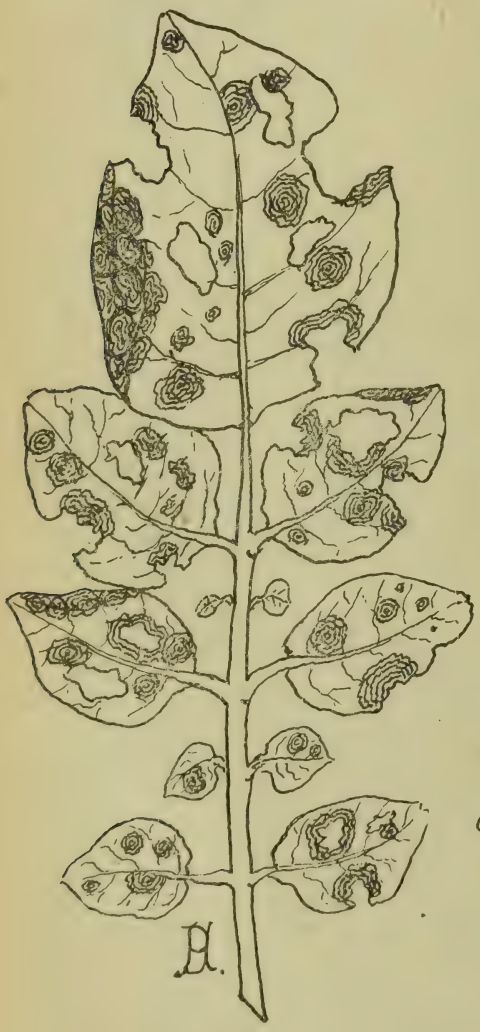


Fig. 10. Early Blight.

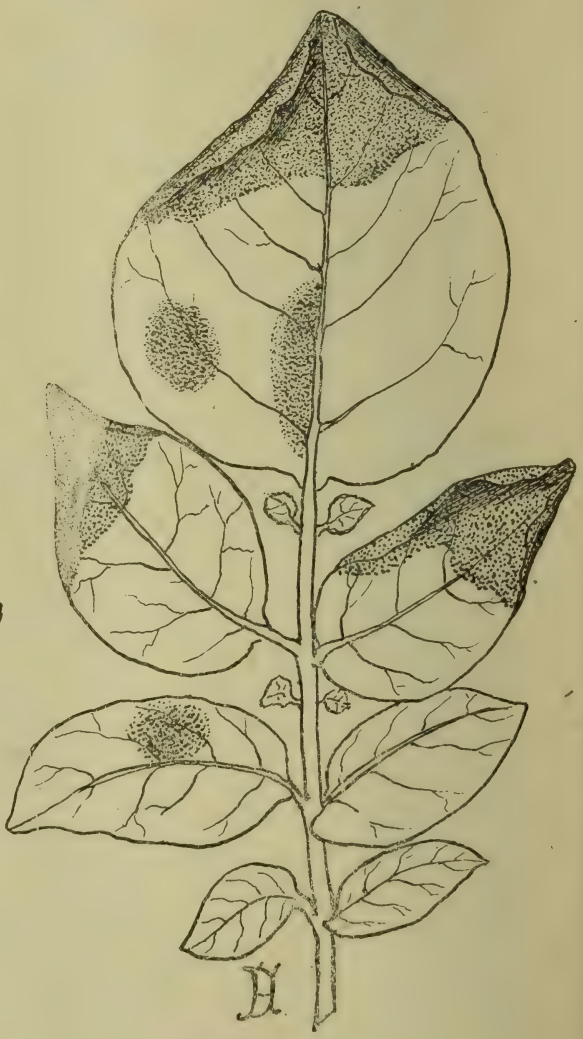


Fig. 12. Late Blight.

First, the size, shape, and position of the diseased areas are quite distinct. In the Early Blight, these areas are small and circular, except where several have run into each other, in which case the diseased areas will be irregular in outine. The leaf diseased or in-

fected by the Early Blight gives one the impression of having been infected at a large number of points. Second, the diseased spots of Early Blight have frequently slight elevations arranged in circles. Third, the leaf affected with Early Blight becomes gradually discolored, has considerable yellow areas, and there is no distinct line of demarcation, as with the Late Blight, between the sound and the diseased tissues. Moreover, the edges of the leaflets affected by the Early Blight have a strong tendency to curl. Fourth, the Early Blight appears earlier in the season than the Late Blight. (See Fig. 10).

Observation shows that the Early Blight is much more severe on the early varieties than on the later-planted varieties. Frequently it has been observed that the early varieties are badly affected, while the later varieties are practically unaffected. In this regard, it appears that the vigorous, growing plants are practically free from the blight, while those which have almost completed their growth are readily attacked. Again, the Early Blight appears to attack potatoes grown upon dry soil rather than those grown under moist conditions, and it is in dry weather that this disease makes the most rapid progress. The Late Blight, on the other hand, requires a moist atmosphere for its development.

The presence of a large number of flea-beetles is no doubt an important factor in the spread of the Early Blight. These minute insects eat small holes in the leaves, and these seem to be the centres of infection. Moreover, plants which have their leaves badly eaten (into pin holes) by the flea-beetles, have their vitality gradually reduced, and are in consequence more susceptible to the Early Blight.

During the later stages of the disease the leaves gradually become brown and shrivelled, the stems become yellowish-brown and dry, and in a short time nothing remains but a few withered leaves and stalks, and a number of small, half-developed tubers. These tubers do not rot; but on account of the death of the tops, they remain small through lack of nourishment.

With regard to treatment, a combination of Bordeaux Mixture and Paris Green is usually quite effective. This mixture should be applied when the plants have reached the height of three or four inches, and should be repeated every two weeks through June and July. The object of the Paris Green is to control the flea-beetles, and of the Bordeaux to prevent infection by the fungus spores. (Fig. 11)

2. The Late Blight of Potato or Potato Rot, under certain conditions, spreads with great rapidity, and causes the destruction of large areas of potatoes in a few days. Such conditions are a temperature of 70 degrees F. and a close damp atmosphere in August and September. On the other hand, a hot dry atmosphere checks the development of the disease. Fortunately, in Ontario the conditions favorable to the development and spread of this very destructive blight do not often occur.

A close study of leaves affected with this blight will usually reveal the following decided peculiarities: First, the edges are most commonly the first portions of the leaves to become diseased, probably because in periods of excessive moisture the edges are kept longer moist than the inner parts. Second, there is a sharp line of demarcation between the affected and unaffected areas; and in moist, warm weather when the affected areas are enlarging rapidly, there is a narrow whitish ring between the two areas, which on close examination shows the fruiting bodies of the fungus. Figs. 12 and 13).

It is usually supposed that this fungus attacks the tubers as well as the stalks and leaves; but the mode of infection has not been definitely proven. The threads of the fungus may grow down through the stem and along the root-stocks to the tubers; or, the spores from the diseased leaves may be carried by rain, etc., to the tubers, which soon become infected.

It is not definitely known how this fungus winters, inasmuch as wintering spores (Oospores) have not been observed. It is very probable that the threads (mycelia) of the fungus live over winter in the affected dormant tubers, and from these the following season make their way back to the stalks and leaves.

Remedial Treatment. As a matter of experience, the Late Blight is more readily combatted than the Early Blight is. Bordeaux Mixture is the sovereign remedy. If the potatoes are thoroughly sprayed every two weeks, beginning about the middle of July, and continuing up to the middle of September, very little trouble will be experienced in growing large crops of healthy potatoes.

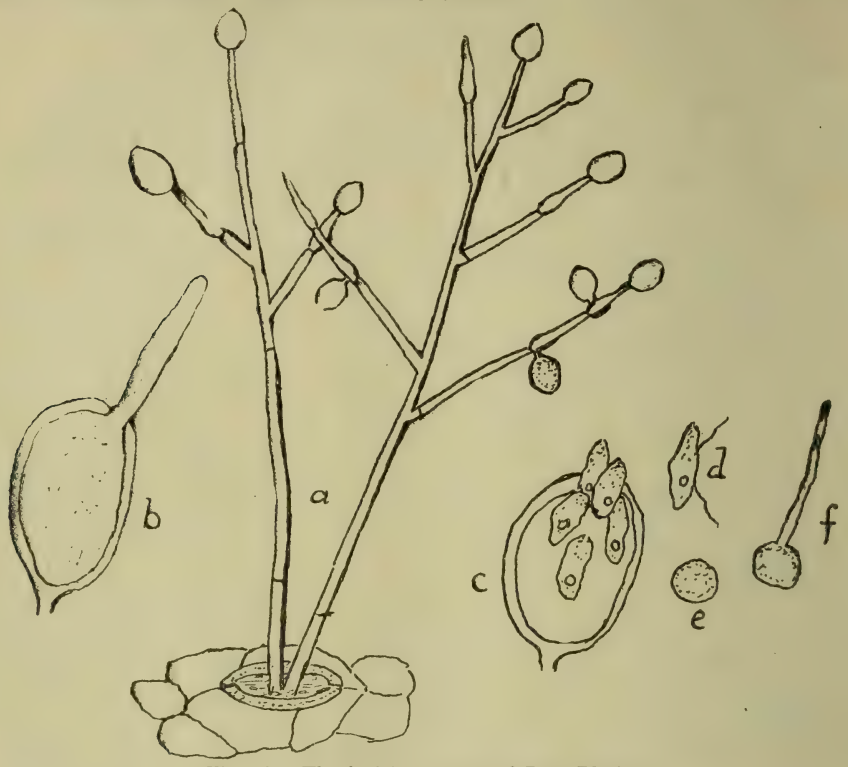


Fig. 13. The fruiting organs of Late Blight.

(*a*) The branching stalks which issue from a breathing pore of the leaf, and the spores. (*b*) A simple spore or conidium germinating. (*c*) A sporanguim with contained zoospores. (*d*) A zoospore with its two whips. (*e*) A zoospore after losing its whips. (*f*) A zoospore germinating. (All magnified.)

Injurious Insects.

I have dealt elsewhere (in the Annual Report of the Entomological Society of Ontario) with the chief injurious insects of the farm, orchard, and garden for the season of 1903. Briefly, however, I may state that the year 1903 has not been marked by many serious outbreaks, and most crops have not suffered to any large extent from insect depredations. The Hessian Fly and Pea Weevil are no longer destructive; the San Jose Scale is more destructive than ever before, but the fruit growers are fast coming to the conclusion that the insect must be fought by the application of right measures. The second brood of the Codling Moth did a great deal of harm in the latter part of the season; and the Apple Aphis was one of the most destructive insects in the Grimsby-Burlington district.

On account of the prevalence of the Pear Tree Psylla in the Grimsby-Burlington district during the past season, and the fear that it will become a decided pest in 1904, I am taking the liberty of giving the latest information regarding this insect.

Pear Tree Psylla.

Reports from Grimsby and Burlington state that the injury done by the Pear Psylla was very marked during the past season, and fears are entertained that much damage may be done to the pear orchards the coming season.

The Pear Psylla was probably introduced into Ontario about 1890 or 1891 from infested New York nurseries. At that time the pear orchards of New York suffered very severely from the attacks of this insect.

It is not difficult to detect the presence of the Psylla in an orchard. The leaves droop, turn yellow, and drop early in the season, while the fruit falls before it is half grown. More conspicuous even is the abundance of "honey-dew," which covers all parts of the trees and is a secretion of the insect. This honey-dew is clear liquid that is exuded, but soon becomes covered with a black fungus growth, which gives the tree the appearance of being coated with soot.

The adult Psylla is a very minute insect. Its color is red, with several black bands across the abdomen. On account of its jumping habit it is often called The Jumping Louse. (Fig. 14).

Fig. 14. (*a*) Adult winged Pear Psylla; (*b*) Nymph or young form of the same insect, much magnified. (After Slingerland.)

Its life-history may be given as follows: The adult winged insect passes the winter hidden in the crevices of the loose bark on the tree. In early spring, about the end of April, the eggs are deposited, usually about the base of the terminal buds of the previous year's growth and in the crevices of the bark. They are light yellow in color and are stalked, provided with a thread-like process. In about three weeks all the eggs are hatched and the young Psyllas can be found feeding at the axils of the leaves. In about thirty days after hatching (about June 15), they become mature, and in another week the egg-laying commences again. There are practically three summer broods of this insect.

On account of the larger size of the adult wintering form, it was formerly supposed by many observers that the summer forms and the winter forms were distinct species.

This insect may be controlled at different times of the year and by different insecticides.

1. Wintering adult forms being inactive, readily succumb to treatment. Among the insecticides which may be used to advantage are: Kerosene emulsion (dilute from seven to nine times), whale oil soap solution (one pound in one gallon of hot water.) lime-sulphur mixture, and crude petroleum. It is necessary to wet the trunk and limbs thoroughly to destroy the hibernating forms.

2. About May 15th, when the spring brood has just hatched, the young lice are very readily killed by such solutions as kerosene emulsion. Treatment during the summer is not recommended, as the adults are very active, and the large amount of honey-dew prevents ready access to the limbs and foliage.

Respectfully submitted.

W. LOCHHEAD,

Professor of Biology and Geology.

BIRDS OBSERVED BY WELLINGTON FIELD NATURALISTS CLUB, 1903.

(T. D. Jarvis, B.S.A., President ; A. B. Klugh, Secretary.)

COMPILED BY THE MEMBERS.

NOTE.—All remarks given below apply to this year only. When a species is enumerated twice the first line refers to the spring migration, the second to the fall.

S—In several. F—In flocks.

Name of bird.	First seen.	About how many were seen.	Next seen.	Became common	Last seen.	Common or rare.	Does it breed near your station.	Remarks.
Chickadee	.....	....	.....	Res'dt..	.....	C	.....	
White-breast Nuthatch....	.....	....	.....	" ..	.....	C	..	
Downy Woodpecker	.....	....	.....	" ..	.....	C	.....	
Hairy Woodpecker	.....	....	.....	" ..	... .	C	.....	
Brown Creeper.....	.....	....	.....	" ..	.....	C	.....	
Pileated Woodpecker.....	.....	....	.....	" ..	.....	Rare ...	.....	
Junco	.....	....	.....	" ..	.....	C	.....	Abundant in spring.
Am. Goldfinch	.....	....	.....	" ..	.....	C	.....	
Horned Lark.....	.....	....	.....	" ..	.....	C	.....	
Crow	.....	....	.....	" ..	.....	C	.....	
Blue Jay	... ...	....	.....	" ..	... ..	C	.....	
Ruffed Grouse.....	... ...	....	.....	" ..	.....	C . ..	.....	
Screech Owl.....	.....	....	.....	" ..	.....	C	.....	
Great Horned Owl	.....	....	.....	" ..	....	Fairly C	.. ..	
Saw-whet Owl	.....	....	.....	" ..	.....	Scarce..	.....	
American Goldeneye.....	Jan. 19	1 ..	April 1	.....	April 30	Fair'y C	No...	Visitor during migrations.
Cooper's Hawk	" 19	1 ..	Feb. 6	.....	Oct. 29	"	Yes ..	Common during open winter 1902-3.
Long-eared Owl	Feb. 6	1 ..	May 30	.....	May 30	Scarce..	.....	
Bluebird	Mar. 9	S ..	Mar. 11	Mar. 15	Oct. 21	C	Yes ..	
Song Sparrow	" 10	S ..	" 12	" 14	" 21	C	" ..	
Killdeer Plover	" 10	1	" 13	" 16	" 21	C	" ..	
Robin ..	" 11	S ..	" 12	" 13	Nov. 30	C	" ..	
Golden-crowned Kinglet..	.....	...	.....	Win. res	... .	C	....	
Bronzed Grackle	Mar. 11	2 ..	Mar. 16	Mar. 17	Oct. 11	C	Yes ..	
Meadow Lark..... ..	" 16	1 ..	" 18	" 18	" 19	C	" ..	
Red-shouldered Hawk ..	" 17	1 ..	" 20	" 30	" 3	C	" .	
Rusty Blackbird	" 17	F ..	.....	.....	" 28	C	No...	
Flicker	" 19	1 ..	" 28	Mar. 31	Sept. 30	C	Yes ..	
Canada Goose	" 20	F ..	" 25	.. ..	.....	.....	No...	
Cowbird	" 20	F ..	" 21	Mar. 26	Oct. 3	C	Yes ..	
White-rump Shrike.....	" 26	3 .	" 28	.....	Aug. 17	Scarce..	" ..	Very scarce this year.
Red-winged Blackbird....	" 26	S ..	" 28	April 1	Oct. 24	C	" ..	
Phoebe	" 26	3 ..	" 29	Mar. 30	" 3	C	" ..	
Winter Wren	" 26	1 ..	" 31	April 4	Nov. 12	C	" ..	
Wood Duck.....	" 27	2 ..	.....	.....	.....	Rare ...	.....	
Marsh Hawk.....	April 1	2 ..	April 15	..	Sept. 16	C	Yes ..	
Vesper Sparrow.....	" 1	1 ..	" 6	April 10	Oct. 21	C	" ..	
Am. Scaup. Duck.....	" 1	S ..	.....	.....	" 11	Scarce..	No...	Not as many noted as usual.
Black Duck	" 1	S ..	April 25	.....	" 25	"	" ..	
Pied-billed Grebe.....	" 1	7 ..	.....	.....	" 25	Fairly C	" ..	
Am. Herring Gull.... ..	" 1	1 ..	April 4	.....	Nov. 11	Scarce..	" ..	
Buffle Head	" 1	S .	" ..	.....	.....	"	" ..	
Ruby-crowned Kinglet...	" 2	F ..	April 4	April 21	May 5	.....	.....	
Ruby-crowned Kinglet....	Sept. 11	1 ..	Oct. 3	Oct. 3	Oct. 14	C ..	No...	
Purple Finch	April 2	1 ..	April 5	April 18	Oct. 3	C	Yes ..	Common migrant. Scarce breeder.
Kingfisher	" 8	1 ..	" 17	" 21	" 29	C	" ..	
Gt. Blue Heron	" 11	30..	" 29	.....	Sept. 23	Fairly C	" ..	Not as numerous as usual.
Tree Swallow.....	" 13	2 ..	" 16	April 19	Aug. 17	C	"	
Yellow-bellied Sapsucker .	" 16	1 ..	" 18	" 18	Oct. 3	C	" ..	Rare as breeder.
Fox Sparrow	" 16	F .	.....	.....	" 30	Scarce .	No...	
Am. Sparrow Hawk	" 17	1 ..	April 24	.....	" 3	C	Yes ..	
Barn Swallow	" 18	S ..	" 20	May 9	Sept. 4	C	" ..	

BIRDS OBSERVED BY WELLINGTON FIELD NATURALISTS CLUB.—*Continued.*

Name of bird.	First seen.	About how many were seen?	Next seen.	Became common	Last seen.	Common or rare.	Does it breed near your station?	Remarks.
White-throated Sparrow	April 19	2	April 23	April 29	Oct. 12	C	Yes	Very com'n breeder.
Holboell's Grebe	" 19	1	" 20		" 21	Rare	No	
Mourning Dove	" 20	1	" 21			Fairly C	Yes	
Chipping Sparrow	" 20	2	" 24	April 24	Oct. 15	C	"	
Wilson's Thrush	" 22	1	" 23	" 23	Sept. 11	C	"	
Am. Woodcock	" 24	1	" 27		Oct. 30	Scarce	"	
Savanna Sparrow	" 24	C			" 3	C	"	
Am. Bittern	" 25	2	May 17		Sept. 12	Fairly C	"	Not as numerous as usual.
Swamp Sparrow	" 25	1	" 1	May 1		C	"	
Lesser Scaup Duck	" 25	F	April 30		April 30	Scarce	No	
Chimney Swift	" 29	S	" 30	May 5	Sept. 5	C	Yes	
Black-th'd Green Warbler	" 29	1	" 30	April 30	" 30	C	"	Very com'on breeder and abundant passing migrant.
Black & White Warbler	" 29	S	" 30	" 30	" 13	C	"	
Water-thrush	" 30	S	May 4	" 30	Aug. 29	C	"	
Blue-headed Vireo	" 30	1			Sept. 20	Scarce	No	
Red-headed Woodpecker	" 30	1	May 9	May 10	" 9	Fairly C	Yes	Not quite as common as usual.
Myrtle Warbler	May 2	S				Scarce		
Myrtle Warbler	Sept. 5	S	Sept. 24		Oct. 24	C	No	
Brown Thrasher	May 2	1	May 10		Aug. 17	Scarce	Yes	
Yellow Warbler	" 4	F	" 5	May 8	" 17	C	"	Not as c'm'n as usual
Parula Warbler	" 4	S				Rare	No	
Oven-bird	" 4	1	May 5	May 12	Sept. 22	C	Yes	
Kingbird	" 4	1	" 8	" 10	" 2	C	"	
House Wren	" 4	2	" 5	" 8	" 25	C	"	
Chestnut-sided Warbler	" 4	1	" 11	" 12	Aug. 17	Fairly C	"	Common migrant. Scarce breeder.
Warbling Vireo	" 6	1	" 9	" 15	Sept. 20	C	"	
Spotted Sandpiper	" 6	S	" 8	" 9	Aug. 12	C	"	
Nashville Warbler	" 9	C			Sept. 23	Fairly C	"	Common migrant. Fairly c. breeder.
Redstart	" 9	S	May 12	May 18	" 11	"	"	Common migrant. Scarce breeder.
Bobolink	" 9	S	" 10	" 11	Aug. 10	C	"	
Crested Flycatcher	" 9	C			Oct. 4	C	"	
Bank Swallow	" 9	S	May 9		July 6	Fairly C	"	Very local.
Baltimore Oriole	" 10	1	" 13	May 15	Aug. 26	C	"	
Maryland Yellowthroat	" 11	1	" 16		" 3	Fairly C	"	
Catbird	" 11	S	" 15	May 20	Sept. 22	C	"	
Scarlet Tanager	" 12	1	" 16		" 23	C	"	Abundant during spring migr.
Yellow-th'd Vireo	" 12	1			" 1	Scarce	No	
Blackburnian Warbler	" 12	1	May 13		May 18			
Blackburnian Warbler	Aug. 27				Sept. 1	Fairly C	No	
White-crowned Sparrow	May 12	1				Rare	"	
Black-billed Cuckoo	" 12	1	May 18		Aug. 12	Scarce	Yes	Very sc'ce this year.
Wood Thrush	" 12	S	" 17		Sept. 13	C	"	Common migrant. Scarce breeder.
Red-eyed Vireo	" 13	S	" 14	May 13	" 24	C	"	
Canadian Warbler	" 13	C			" 11	C	"	
Rose-breasted Grosbeak	" 15	1	May 16		" 1	Fairly C	"	
Purple Martin	" 17	2	June 4		July 20	Scarce	"	A few p'rs nest at two buildings in city.
Magnolia Warbler	" 17	1	May 18		May 22	"		
Magnolia Warbler	Aug. 27	F. S	Aug. 28	Aug. 27	Sept. 23	C	No	
Mourning Warbler	May 17	1	May 1		Sep. 16	Fairly C	Yes	Common migrant; scarce breeder.
Bay-breasted Warbler	" 18	S				Scarce		
" "	Aug. 27	F. S	Aug. 28	Aug. 27	Aug. 28	C	No	
Yellow-billed Cuckoo	May 18	1	June 19		" 13	Rare	Yes	
Wood Pewee	" 18	S	May 19	May 19	Sep. 26	C	"	
Least Flycatcher	" 18	C			" 25	C	"	
Indigo Bunting	" 19	C			Aug. 7	C	"	

BIRDS OBSERVED BY WELLINGTON FIELD NATURALISTS CLUB.—*Concluded.*

Name of bird.	First seen.	About how many were seen.	Next seen.	Became common.	Last seen.	Common or rare.	Does it breed near your station.	Remarks.
Nighthawk	May 19	1	May 22		Sep. 19	C	Yes	
Loon	" 20	1				Rare	No	
Ruby-thd Hummingbird	" 20	2	May 30		Sep. 1	Fairly C	Yes	
Sharp-shinned Hawk	" 23	1	June 7		" 5	Rare	"	Scarce migrant; rare breeder.
Black-th'd Blue Warbler	" 24	2			" 25	"	"	
Cliff Swallow	" 25	S	May 31		Aug. 17	Fairly C	"	Very local.
Cedar Waxwing	" 29	S	" 30	May 30	Sep. 26	C	"	
Whip-poor-will	" 30	1				Rare	"	
Osprey	June 2	1	Sep. 2		Oct. 3	Scarce		
Blue-wing Teal	" 2	3				"	Yes	
Traill's Flycatcher	" 14	2			Sep. 12	"	"	Scarce breeder.
Least Sandpiper	July 16	S			Aug. 28	"	No	
Solitary Sandpiper	" 19	3	July 20		Sep. 2	Fairly C		
Green Heron	Aug. 7	1	Aug. 17		Aug. 26	Scarce		
Black-poll Warbler	" 17	F				Rare	No	
Sara Rail	" 17	S	Aug. 18			Scarce	Yes	
Virginia Rail	" 20	S				"	"	
Red breasted Nuthatch	" 26	F. S	Aug. 27		Oct. 4	C	No	
Philadelphia Vireo	" 27	3	" 28		Sep. 1			
Wilson's Warbler	" 28	F. S	" 29		" 12	Fairly C	No	
Broad-winged Hawk	Sep. 12	F	Sep. 13		" 21	"	"	
Red-tailed Hawk	" 13	1	" 19		Nov. 5	Scarce		
Olive-backed Thrush	" 12	F				"	No	
Hermit Thrush	" 29	2	Oct. 20		Oct. 20	"		
Green-wing Teal	Oct. 4	F				"	No	
Redhead	" 4	2	Oct. 21		Oct. 21	"	"	
Am. Pipit	" 4	S			" 28	Fairly C	"	
Tree Sparrow	" 21	F. S	Oct. 23	Win. vis		C		
Canvas-back Duck	" 25	1				Rare	No	
Redpoll	" 28	F. S	Oct. 29	Win. vis		C		
Pigeon Hawk	" 30	1				Scarce	No	
Wilson's Snipe	Nov. 4	2					"	
Pine Grosbeak	" 5	F. S	Nov. 6	Nov. 5		C		Very common.
American Merganser	" 18	3				Scarce	No	
Snowflake	" 21	F. S	Nov. 25	Win. vis		C		
Northern Shrike	" 28	1		"				
Pine Siskin	Dec. 4	F		"				

PART V.

THE PROFESSOR OF CHEMISTRY.

To the President of the Ontario Agricultural College :

Sir,—I beg to submit herewith my Third Annual Report. The work of this department will be taken up under three headings : Teaching, Miscellaneous Work, including correspondence, addressing meetings, etc.; and Investigation Work. Under teaching, I refer particularly to the instruction given to students in attendance at the College. This I look upon as our most important work, and a very earnest effort has been made to make it as thorough as possible. The answering of letters of inquiry on practical points and the addressing of agricultural meetings is also important work, for it brings us into contact with the every-day difficulties experienced in farm work. Naturally these difficulties suggest lines of investigation that we would like to undertake ; but our time is so occupied by the work previously mentioned that it is practicaly impossible to undertake much research work. We have, therefore, sought to direct our energies more to the bringing out of practical results based on the scientific research of others.

As stated in last year's report, W. P. Gamble, B.S.A.,Lecturer in Chemistry, was given charge of the Dairy Chemistry work. During the last two years, he has analysed a large number of samples of mill by-products. His report on this and the teaching of Inorganic and Dairy Chemistry will be found in Part VI. of this volume.

Mr. W. C. Good, B.A., Demonstrator in Chemistry, resigned last September to return to his farm in Brant County. I was sorry to lose Mr. Good, as he rendered very efficient service while he was with us. Mr. E. G. de Coriolis, B.S.A., '03, who was appointed to fill the vacancy, commenced his new duties on the first of September.

Teaching.

It may not be out of place to give a brief outline of the work under this head. Instruction is given in the following branches of chemistry : Inorganic; Organic; Agricultural, including the chemistry of plant growth, soils and fertilizers ; Animal, including the chemistry of animal nutrition, foods and feeding; and Dairy chemistry, which comprises a chemical study of milk and its products. Qualitative and Quantitative analysis is also taught, and advanced work is done in the analysis of water, soils, fertilizers, foods, and dairy products.

These subjects are taken up in the following order : Three lecture periods per week throughout the whole of the first year are spent on Inorganic chemistry. During this time, both by lectures and by experiments performed by the students themselves in the laboratory, we seek to make plain the fundamental laws of chemistry and the properties of the more common elements. In the second year, about six weeks, with three lectures per week, are spent on Organic chemistry. The main object sought is to make the students familiar with the relation between starches, sugars, alcohols, acids, and etherial salts, and to show what fats, amides, etc., are. This is necessary for the proper understanding of the Agricultural and Animal chemistry, which takes up the remainder of the year. One afternoon each week is devoted to experiments planned to demonstrate the work taken in the lectures. This is the work in Chemistry for the Associate Diploma.

Students taking up the work of the third and fourth years with the intention of trying for the degree of Bachelor of the Science of Agriculture, are given further work

in Inorganic and Organic chemistry. I feel that a thorough knowledge of these subjects is essential to an understanding of the many intricate points which arise in the work of the farm and dairy. Consequently, the third year men are given three lectures per week in Inorganic chemistry until Christmas, with two afternoons of three hours each on the qualitative separation of the metals and acids. The remainder of the year is spent in Organic chemistry and quantitative analysis, leading into the analysis of fertilizers. In the fourth year, the methods employed in research work in Agricultural and Animal chemistry, the results obtained and their value in a practical way to the farmer, the stockman, and the fruit grower are discussed. Analyses of fertilizers, soils and fodders are also made, in order that the students may know something of the advantages and the limitations of such analyses. The specialists in Chemistry and Physics are given more difficult work in Organic and Inorganic chemistry and a wider training in the analyses of Agricultural products. Those taking the option in Dairying receive special training along their particular line.

In addition to this work in the College proper, a course of twelve lectures, with twelve half-days of laboratory instruction, was given in the Winter Term to the students of the Dairy School; and the Short Course men in Poultry received four lectures on foods. During the year, three men have been given special instruction, independent of the regular classes, in particular lines of work which they wished to take up.

In all the work of instruction, both in class-room and laboratory, we have always sought to keep the practical side prominent and to deal with the various subjects in such a way as to arouse the interest of the student in his work. I fully believe that if the boys can be led to inquire into the hidden meaning of the various farm operations we will hear less about the drudgery of farm work.

Miscellaneous Work.

After the teaching, perhaps the most important part of my work is attention to correspondence. It is gratifying to note that the general correspondence is increasing; for it indicates that the farmers have confidence in the College and are looking to us for information. During the last year, an increasing number of samples of a great variety of substances have been sent in for analysis. In some cases, the required information could be given without a full analysis; but, sometimes, only a complete analysis would give the information required, and then only if the sample has been accurately taken. Therefore, while I am anxious to comply with the request of all correspondents and give the fullest information possible, it has not always been thought wise to analyse all samples received.

Correspondence is sometimes of value in indicating the needs of investigation along certain lines. Recently a large number of inquiries were received regarding the food value of the various mill by-products of the Province. Seeing the need for some definite information on this subject, Mr. Gamble collected a large number of samples of these substances and analysed them, and now has the material ready for a bulletin dealing with the composition of these products.

During the last two years, but especially during the last year, a number of samples of swamp soils, rich in vegetable matter, have been sent in for examination. Most of these soils contain an abundance of plant food, and yet are unproductive. We, therefore intend making a fuller investigation of soils of this nature, and will be glad to receive samples of such soils, together with the fullest possible information regarding their previous treatment. At my request, Mr. de Coriolis, Demonstrator in Chemistry, has prepared the following short paper dealing with some of the most common needs of these swamp soils.

Investigation of the Composition of Soils Rich in Vegetable Matter.

With the breaking of land and the draining of swamps, many soils are put under cultivation which are rich in vegetable matter. Many such soils exist in Ontario, and

nothing has been done so far in the way of research along those lines. It has, therefore, been deemed necessary by this department to carry on some investigation as to the nature and composition of these soils.

So far, very few soils have been analysed, the reason for it being that the operation is rather long, and class work and other work leave very little time which can be devoted to analysis.

The proper way to carry on investigation on the above mentioned soils, to make the results practical and valuable, would be to find out their composition, the amount of available plant food they contain, and how farm crops, such as oats and barley, grow on them. This has been done with some soils. They were collected from the different fields and woods on the College farm, from places which were actually swampy or which but recently had been placed under cultivation. The results of the analyses go to show that they contain a sufficiently large amount of total plant food, and that in composition they compare favorably with the ordinary agricultural loam. The main points in which they differ from the loam are their richness in nitrogen (which is to be expected, owing to their formation from organic and nitrogenous matter), and their deficiency in potash. This last named constituent is one which needs most serious consideration. As is well known, the main natural source of potash in soil is from the rock particles which are found on most arable land and known as feldspars. By means of the various agents of erosion and weathering, the feldspar (Orthoclase), which is a double silicate of aluminium and potassium, breaks down, yielding soluble compounds of potassium. In drained swamps such rock particles are generally absent, and the supply of potash in the soil is naturally limited. Again, it seems that the amount of available potash is smaller in soils, rich in vegetable matter, than in ordinary clay loams, especially so, if the soil is not in a very good physical condition. In one of the soils analysed, this was most noticeable. The soil had been under cultivation for about fifteen years; but being in a low spot, it had never been effectually drained. Some of it was placed in a pot and sown with oats ; and the plants, after growing four inches, died; while side by side with them were plants growing vigorously in other soils, which by analysis had shown a larger percentage of available potash.

Another point to be noticed about soils rich in vegetable matter is that, although they contain a large amount of total nitrogen, that element is in an organic form and not as nitrates, the form of combination which is most available to plants. The apparent reason for this is that such soils owe their formation mostly to decayed vegetable matter which accumulates in swamps where nitrification, the process by which organic nitrogen is converted into nitrates, is practically at a standstill. There is even a reverse process known as denitrification, which is supposed to be active in breaking up nitrates and liberating ammonia. Both these processes are brought about by the activity of certain living organisms known as nitrifying and denitrifying germs. When a swamp is drained and placed under cultivation, the germs that are most active are the denitrifying germs. In fact, the nitrifying germs are very often absent. A soil in such condition may be given the best treatment possible, without any satisfactory returns. Before it will produce crops, it must be inoculated with nitrifying germs. On a small scale, this may be done by adding some garden loam to the soil, the garden loam being known to be fairly rich in nitrifying germs.

To test the above mentioned facts, an experiment was conducted this summer on the soil analysed last year, which showed a great lack of available potash. Some of the soil was taken and distributed in three large-sized flower pots and sown with oats. To pot No. 3, a handful of garden loam was added ; in pot No. 2, some muriate of potash was sown with the oats; and nothing was added to pot No. 1.

The accompanying photographs prove pretty conclusively that what was lacking in the soil was not so much the potash as the nitrifying germs. The growth in pot No. 3, in which the soil was innoculated, greatly surpassed that in No. 2, to which potash

was added; and the stunted growth in No. 1 shows clearly the beneficial effect which the plants in No. 3 obtained from the nitrifying germs.

Another point to be noticed about soils rich in vegetable matter is that during the decomposition of the organic matter large quantities of various acids are formed. These must find in the soils bases with which to combine, or else the excess of unneutralized acid present will become injurious, arresting the important function of nitrifying germs.

Pot experiments with soil rich in vegetable matter.

Pot. 1. Soil alone. Pot. 2. Soil and muriate of potash. Pot 3. Soil and garden loam.

The most common base with which these acids combine is lime; and it has been found that soils containing a large amount of free acid are generally lacking in that constituent.

What has been said above about soils rich in vegetable matter is based on deductions from the results of a few analyses. Some facts regarding the nature and composition of soils rich in vegetable matter have been noticed; but, before drawing any definite conclusions, we must wait until further experiments have been made, with a view to throwing additional light on the subject.

E. G. De Coriolis.

Last winter the Dominion Master Bakers' Association, with the consent of the Minister of Agriculture, organized a Bakers' School, the first session of which was held in Toronto last April. It was only a two days' session; but the attendance of both master and journeymen bakers from different parts of the Province was good. At this school I delivered two lectures on questions relating to the Chemistry of Flour and Breadmaking. I also gave a lecture on the Chemistry of Flour at a joint meeting of the Dominion Master Bakers' Association and the Dominion Millers' Association held in Toronto in September. In addition to this, for the last three years I have addressed the ladies of the Ontario Normal School of Domestic Science and Art, Hamilton, on "Flour." In the past, I have done some chemical work on Ontario wheats and flours, part of which has been published; but, in view of the fact that millers and bakers are becoming more interested in the scientific side of their work, and are looking to us for assistance, and also to the fact that, through the generosity of Sir William Macdonald, of Montreal, a School of Domestic Science has been established at the College, I felt the need of doing more work along these lines and of studying the methods of investigation followed elsewhere. Consequently I applied, through you, to the Minister of Agriculture, for permission to go to Minneapolis, Minnesota, to see something of the work done in testing wheat and flour in the large flour mills there. My request was granted, and in August I spent sometime in the laboratories of the Northwestern Consolidated Milling Company and the Pillsbury Milling Company, Minneapolis. I also spent a day with Mr. Howard, who tests flour for the smaller milling companies that have not laboratories of their own.

While in his laboratory, I had the pleasure of seeing the first test of flour made from wheat grown in Manitoba in 1903. In all these laboratories, the principal tests are for color and strength of flour and quality of the bread it will produce. The quantity and quality of glutens are determined; but the main dependence is placed on the baking test. In the larger mills, these baking tests are made daily, and the bread is compared with that got from a standard flour. In this way, they seeek to keep their various grades of flour up to standard. At the Minnesota Experiment Station, I met Prof. H. Snyder, who has possibly done more work on the chemical side of wheat and flour in its relation to breadmaking than any other man in America. From him I got some information that will be of value in our work here.

At the request of the Referee on "Food Analysis" of the Official Agricultural Chemists' Association, we co-operated in the study of new methods for the analysis of flour. A report of our results was duly forwarded to the Referee, and it was incorporated in his report to the Association. As Referee on "Vegetable Proteids" for the same Association, I found, owing to the vagueness of the literature on the subject, and to the difficult nature of the separations of the various classes of proteids, that I could do nothing more than read up the literature on the subject, and report the present state of knowledge of these complicated compounds, or, as is commonly said, "report progress." It is well known that all proteids have not equal food value. Our old methods of analysis do not provide for the separation of these bodies. Therefore, if we wish to gain a fuller knowledge of the feeding value of the common cattle foods, especially those fed in an immature state, it is important that means be devised for making their determination. Hence the value of this work.

I have been asked to act as Referee on Vegetable Proteids for another year; but, important as this work undoubtedly is, I feel that it would occupy more of my time than I can afford to give to it, and consequently I have declined to act.

Investigation Work.

Wheat and Flour. The wheat grown in Manitoba and the Northwest Territories in the season of 1902 was a good sample and weighed well; but the millers were unable to make a strong flour from it. The bakers claimed that the flour was weak and would not stand the proper amount of fermentation; and yet it seemed to contain a fair amount of gluten. Complaints were so general that we were asked to examine the flour, and, if possible, find out what was wrong with it. The analysis showed that the gluten was poor in quality. The gluten of flour is made up of two nitrogenous bodies, gliadin and glutenin. The gliadin, or plant glue, as it is sometimes called, is the substance which gives tenacity to the dough. It is due to the elasticity of this gliadin that the gases produced during fermentation are retained in the dough and the dough is said to "rise." If the amount of gliadin is low, the gases break through and escape and the dough does not rise properly. The "Patent" grades of flour always contain more gliadin than the lower grades, made from the same wheat, and, consequently, are stronger flours, and the dough rises better. On examining the flours made from wheat grown in the West in 1902, we found that they were all very low in gliadin. The following results show the difference in this respect between flours from wheat grown in 1901 and 1902:

Percentage of Total and Gliadin Nitrogen in Flour.

1901.	Total Nitrogen.	Gliadin Nitrogen.	Per cent. of total Nitrogen in Gliadin form.
Manitoba "Patent"	2 05	1.39	67 3
" "Bakers"	2 12	1.33	62.7
Ontario "Patent"	2.07	1.31	63.3
1902.			
Ontario "Patent	2.25	1.09	48.5

These figures show that the amount of gliadin in the wheat grown in 1902 was much lower than in the wheat of 1901. Some of the soft varieties of wheat contain too much gliadin to make gluten of the best quality. Consequently, the mixing of the flour from wheat grown in the west in 1902 with some of the softer varieties of Ontario should give better results. This was recommended at the time. The wheat grown in 1903, while not so fine a looking sample as that of 1902, contained more gliadin, and the flour was satisfactory to the baker.

During the year we have made determinations of the quality and quantity of gluten contained in wheat cut at three different stages of maturity, that is, just before it was ripe, when it was ripe, and when it was over-ripe. This work was done with two varieties of wheat, and indicates that there is considerable falling off in quantity of gluten when the wheat becomes over-ripe. We wish to repeat the work on other varieties before publishing the figures obtained.

Some other work in connection with the study of the quality of wheat has been undertaken, and considerable time has been spent on it; but the work is not far enough advanced to report at present.

Soils and Fertilizers.

The following experiment with fertilizers was undertaken to illustrate a practical method of determining whether a given soil is deficient in any of the important constituents of plant food. Too often farmers and others in writing for information regarding soils, fancy that we can, after making an analysis, tell them exactly what is lacking and how that particular soil should be manured to produce the best results. Unfortunately the analysis of a soil is a long and tedious process, and the methods of analysis have not been so perfected as to give all the information desired. Other circumstances, such as the accuracy of the sample, availability of the plant food, the condition of the soil regarding cultivation, drainage, etc., have an important bearing on the subject. Soil analyses have their place, and are of value; but in many cases it is much more simple and more practical to let the soil speak for itself.

The soil used in this experiment was a clay loam on which two or three grain crops had been grown in succession. Seven boxes, three feet long by eighteen inches broad and nine inches deep, were filled with the soil and sown with oats. Fertilizers were then applied as follows:

Box No. 1. Nitrate of Soda.
Box No. 2. Muriate of Potash.
Box No. 3. Superphosphate.
Box No. 4. Nitrate of Soda and Superphosphate.
Box No. 5. Nitrate of Soda and Muriate of Potash.
Box No. 6. Muriate of Potash and Superphosphate.
Box No. 7. Mixture of the three.

Plots showing the effect of different fertilizers.

From the illustration, it is evident that the oats grew best in boxes Nos. 4 and 7; but no better in No. 7 than in No. 4. The addition of superphosphate and nitrate of

soda gave as good results as the mixture of all three constituents. Thus, apparently, the oats were able to obtain all the potash they required, and the addition of that substance did not affect the results. Thus, potash would be applied at a loss on this particular soil for the oat crop. Again, it is evident that it required both superphosphate and nitrate of soda to increase the growth. This illustrates the point that plants require their food supplied in a balanced ration. The addition of one constituent to a soil does not make up for its deficiency in another ; but the growth is limited by the supply of the constituent present in the smallest quantity. Therefore, if there is just nitrogen enough in the soil for half a crop and an abundance of the ash constituent, there will be only half a crop, and it can be increased as more nitrogen is added, without increasing the ash constituents.

In actual practice is is well to apply the fertilizers to, say, one-tenth acre plots in the field ; but the plan given above illustrates the principle. By such experiments as these, the farmer can find out for himself better than any one can tell him the needs of his soil. It must be remembered, however, that the various farm crops differ widely in their requirements of plant food, also that the various soils show different needs, and that the same kind of soil may respond differently with the season and treatment. Consequently, every farmer who wishes to keep in touch with the needs of his land should make himself familiar with the food requirements of his crops and study the soil from year to year with some such experiments as outlined. This applies especially to those farmers who are beginning to use artificial fertilizers, for it is impossible to apply these substances intelligently and economically without first knowing what the crop requires in the way of plant food and what the soil is most deficient in.

Insecticides.

The use of insecticides and fungicides has become almost indispensable to the farmers and fruit growers of this country. As a result, an ever increasing number of these substances are placed upon the market. Some of these are said to kill bugs, destroy fungous diseases, stimulate plant growth, etc., etc. Without a doubt, some of them do meet the claims of the manufacturers ; but there are others which are not of sufficiently high standard to warrant their use, and for this reason commerce in them should be discouraged. In reporting the work done on insecticides, we have no intention of interfering with a legitimate business; but it seems only proper that the retail merchants and the men who use these insecticides should be acquainted with their real characters. The insecticides we have analysed and hereafter reported on are those commonly used on the potato vines.

Paris Green contains as its chief constituent a compound called copper aceto-arsenite. All the arsenic contained in Paris Green is supposed to be held in this compound, and in this form will not destroy foliage. Now, Paris Green, as found in the market, rarely consists of pure copper aceto-arsenite, but contains this compound as its chief constituent, with varying proportions of other substances. Lack of care in the manufacture of Paris Green, and the use of impure compounds, may be sufficient reason for the presence of some free arsenious oxide, gypsum, clay, etc., etc., but this can hardly be said to account for the large quantities of these substances found in some samples. In Bulletin No. 88, Inland Revenue Department, Ottawa, Thomas Macfarlane, Chief Analyst, reports that out of 169 samples of Paris Green analysed in 1902 and 1903 only 7, or 4.1 per cent. were adulterated. On the other hand, last winter one of our students, Mr. J. P. Cleal, collected and examined 23 samples, only 5 of which could be said to be unadulterated. Mr. Macfarlane's samples were collected in the larger cities of the Dominion ; Mr. Cleal's were got almost entirely from country stores, many of them from unsealed packages. In one case, three samples traced to the same source were differently adulterated. The amount of free arsenious acid in Mr. Cleal's samples varied from .9 to .9 per cent., five of them having over 4 per cent. It is the arsenic in this form that burns

the leaf. The quantity of the various substances used to adulterate the Paris Green was not determined ; but, in some cases, it was very large.

A good practical method for ascertaining the purity of Paris Green is to test its solubility in ammonia water. A small portion of the sample to be tested should be placed in a glass dish, a tumbler or goblet will do, and strong ammonia water added. The Paris Green will all dissolve readily, leaving a deep blue solution. Sufficient ammonia water must be added to dissolve all the Paris Green. Any gypsum or clay used to adulterate the sample will settle to the bottom quickly and can be readily seen.

Lime is commonly used with the Paris Green to neutralize the free arsenious acid and prevent scorching of the leaves. Very often, however, the lime is simply mixed with the Paris Green in water and applied at once. A better practice is to allow the two to stand in contact with one another for a little while before applying, in order to give the lime time to combine with the arsenious acid.

Black Death.

One of the newer insecticides recently offered for sale in this Province is "Black Death." It is sold at 2 cents per pound, or 15 pounds for 25 cents. The composition of this substance according to our own analysis is as follows :

Moisture	10.42	Carbon dioxide	7.90
Sand, etc.	6.37	*Paris green	0.43
Carbon	17.39	Undetermined (volatile matter, water of crystallization)	8.31
Sulphur trioxide	23.72		
Calcium oxide	23.30		
Magnesium oxide	2.16		100.00

*Copper oxide, .13 per cent.; Arsenic trioxide, .12 per cent.

This insecticide is composed almost entirely of charcoal, sand, and gypsum. The only substance present which will poison insects is the Paris Green. If mixtures with so small an amount of this poison will kill insects, it will be cheaper to buy a pound of Paris Green and mix it with 200 pounds of gypsum. Paris Green can be bought for 20 cents per pound. In Black Death it costs $3.86 per pound.

Potato Bug Finish.

"Bug Finish" is another insecticide that is now on sale in various localities. It is sold at the same price as "Black Death." The following is the composition of the sample analysed :

Moisture	12.49	*Paris green	1.06
Sand, etc.	17.57	Iron and aluminium oxides	1.13
Insoluble organic matter	0.69	Undetermined (water of crystallization, volatile matter, etc.)	3.54
Sulphur trioxide	30.47		
Calcium oxide	25.79		
Carbon dioxide	5.77		100.00
Magnesium oxide	1.49		

*Copper oxide, .32 per cent.; Arsenious oxide, .70 per cent.

One hundred pounds of this mixture contains only a little over one pound of Paris Green ; the remainder is largely sand and gypsum. The Paris Green in it costs $1.56 per pound.

Kno Bug.

The manufacturers of this insecticide claim that it kills the bugs, stimulates the plant, and improves the quality of the crop. It sells in 20-pound boxes at 6 cents per pound. According to our analysis, it has the following composition :

Moisture	10.89	Iron and aluminium oxides	4.03
Insoluble matter	10.55	Potash, Nitrogen—Potassium nitrate	4.50
Sulphur trioxide	26.10	*Paris green	2.49
Calcium oxide	26.73		
Carbon dioxide	11.95		100.00
Magnesium oxide	3.09		

*Arsenious oxide, 1.46 per cent.

It is essentially crude gypsum with 2½ per cent. of Paris Green, and potash and nitrogen equivalent to about 4.5 per cent. of potassium nitrate. The latter is a valuable plant food; but, as there is only about 25 cents' worth in 100 pounds of the mixture, it does not add very much to its cost. Anyway, it would appear to be a better practice to keep insecticides and fertilizers separate. Without allowing any value for the other materials, the Paris green in this mixture would cost $2.41 per pound.

Slug Shot.

Slug Shot is essentially crude gypsum mixed with small quantities of Paris Green, tobacco, and carbolic acid. It is sold in Guelph at 10 cents per pound, or 3 pounds for 25 cents. In larger quantities it can be bought for much less. The detailed results of our analysis are as follows :

Moisture	13.55	Carbon dioxide	2.79
Sand, etc.	3.53	*Paris green	2.13
Insoluble matter (sulphur, tobacco, etc.)	5.69	Phenol, soluble organic matter, etc. (by difference)	3.38
Calcium oxide	30.10		100.00
Sulphur trioxide	37.93		
Iron and aluminium oxides	0.80		

*Copper oxide, .64 per cent.; arsenic trioxide, .82 per cent.

Carbolic acid is a poison, and as such will, no doubt, destroy bugs as well as the Paris Green; but this mixture at even 5 cents per pound is rather an expensive substance to use in destroying potato bugs.

Bug Death.

Another insecticide that has recently come into great prominence is Bug Death. It is claimed that it kills the bugs, feeds the plant, increases the yield, and improves the quality. It is sold at the rate of 12 pounds for $1, or 100 pounds for $7. The following is the composition of samples secured in 1902 and 1903 :

	1902.	1903.		1902	1903
Moisture	0.32	0.38	Zinc oxide	87.47	83.04
Volatile matter	2.67	2.87	Iron oxide	3.84	4.09
Sand, etc.	3.17	4.26			
Lead oxide	3.17	4.70	Total	100.64	99.34

It is composed largely of crude zinc oxide with small quantities of lead oxide and iron oxide. It also contains nitrogen equivalent to about one-half of one per cent. of ammonium sulphate. This latter substance is a plant food ; but there is so little of it in the mixture that it cannot have much value. Bug Death has considerable fungicidal value, and also destroys the bugs. It has to be applied in fairly large quantities and is rather an expensive substance ; but it has given good results when used on potatoes.

Tests of Different Varieties of Sugar Beets.

At the request of Mr. Zavitz, Experimentalist, we have determined the percentage of sugar in a number of varieties of sugar beets grown on the experimental plots at the College. These beets were grown on the level in rows, 21 inches apart, and thinned so as to leave the plants 8 inches apart in the row. The object of the experiment was to determine the yield and feeding value in so far as they may be judged from the sugar content of the various varieties. The results obtained are also of value, in that it is possible to compare some of the best varieties for sugar factory purposes with the Kleinwanzlebener, which is now looked upon as the standard variety for that purpose in this Province. The following table gives the percentage of sugar in the juice and the purity of the solid of the juice :

Percentage of Sugar in Juice of Beets Grown on Experimental Plots in 1901, 1902 and 1903.

Name of varieties.	1901.		1902.		1903.	
	Sugar.	Purity.	Sugar.	Purity.	Sugar.	Purity.
Red Top	10.9	81.5	10.2	81.0	12 2	87.7
Red Skinned	9.6	78 4	13.8	85.2	16.0	86 0
White Silesian	14.5	86.9	12.5	75 6	16.2	88.5
New Danish	11 4	81.6	11.4	84.1	10.7	80.4
Green Top White	13 6	83.2	13.0	84.9	14.1	85.4
Lane's Improved	11.6	80.9	12.2	84.2	13.7	83.0
Champion	9.6	74.2	16 3	90.0	19.0	90.0
Royal Giant	10.4	83.3	9.5	83 3	11.1	83 9
Giant Red, half sugar	9.6	85 0	10.2	82.3	11.4	80.8
White French	14 4	85.5	9.5	80 5	11.3	84 7
Giant White, half sugar	9.0	74 7	10.1	81.5	9 1	75.2
Pitzseheke's Elite	15 8	82.6	14.6	88 9	17.9	88.6
Jersey	15.6	88.7	12.8	87.7	11.5	83.2
French Yellow	13 3	85 2	13 0	86.9	12 9	80.1
Carter's Nursery	16.1	87.6	10.0	80.9	10.5	80.7
Improved Imperial	16.3	86.4	15.6	90.8	17.9	90.2
Improved Grey Top	14.9	85.7	15 3	88.0	15.7	85.7
Queen of the Danes	13.3	84.8	10.3	81 5	11.1	80.0
Vilmorin's Improved	16 8	88.9	14.4	84 8	15.4	89.1
" French Sugar	14.0	83.6	16 5	90.3	16.3	86.3
Kleinwanzlebener	17.5	89.8	16.3	90.0	17.4	88.3
Mangel Sugar Beet	.....	.....	15.6	87.1	18.3	87.5
Tancred Cream	.....	.....	9 5	80.0	9.3	77.5
Jarnsahic Victrix	.....	.....	16.1	89.5	17.5	87 5
Ideal	.....	.....	7.1	70 6	7.7	70.0
Diechman No. 1	.....	.....	16.1	87 0	17 4	86.1
" No. 2	.....	.....	16.1	88 5	18.1	90.5
" No. 3	.....	.....	16.3	88 5	17.5	89.2
Rubensamen	.....	.....	16.7	88.3	18.2	91.0
C. Vorstadt	.....	.....	16.7	89.1	.....	.....
Hybrid Sugar Beet Mangel	.....	.....	.....	.....	11.1	80.1
Imperial Giant, half sugar	.....	.....	.....	.....	11.3	79.0
Rennie's Giant Sugar	.....	.....	.....	.....	10.9	79.5

The yields obtained with these different varieties will be found in the Report of the Experimentalist, Part XIII. of this volume.

It will be noticed that the larger growing varieties, such as the New Danish, Giant Red, and Giant White, are low in sugar, while the White Silesian and Jersey, much smaller growing varieties, are high in sugar. The indications are that, generally speaking, the larger varieties are not equal to the smaller ones in food value. Looking now to the quality of beets required for sugar factory purposes, we notice that in 1901 no variety was grown which was equal in sugar and purity to the Kleinwanzlebener. In 1902, there were two equal and three slightly better; while in 1903, there as one equal and seven better than this famous German variety.

Test of Quality of Sugar Beets as Affected by the Distance Between the Rows.

In this experiment, as in the last, the beets were grown by the Experimental Department. The seed was sown on the level in rows 12, 14, 16, 18, 20, 22, 24, 26, and 28 inches apart, and, in all cases, thinned so as to leave eight inches between the plants in the rows. This experiment was first carried out in 1902 and was repeated this year. In both years duplicate plots were grown. The results so far as yields are concerned, will be found in the Report of the Experimentalist, Part XIII. of this volume. The effect on the quality, determined at two different dates, 16 days apart, may be seen in the following table:

Composition of the Juice of Sugar Beets Grown in Rows Different Distances Apart.

Distance apart of rows.	Date of lifting.	1902. Average wt. of tared beets.	1902. Analysis of juice. Solids.	Sugar.	Purity.	1903. Average wt. of tared beets.	1903. Analysis of juice. Solids.	Sugar.	Purity.
		ozs.				ozs.			
12 inches	October 3	9 0	16.8	15.0	89.5	8.0	18 9	16.7	88.2
12 "	" 19	9.6	18.5	15.9	85.8	12.2	20 4	17.6	86.5
14 "	" 3	11 1	16.8	14 4	85 5	8.8	18 9	16.5	87.3
14 "	" 19	11.7	18.7	16.2	86.9	12.2	19.6	17.6	90 0
16 "	" 3	13.3	16 6	14 2	85 5	9.4	19.5	16.4	83.9
16 "	" 19	15 3	18.6	16.5	88.7	13.3	20.2	17.8	88.1
18 "	" 3	12.7	16.8	15.0	89.0	10.9	18.7	16.4	87.9
18 "	" 19	12 3	18.3	16.4	89.2	13 7	19 4	17.0	87.3
20 "	" 3	13.2	17.3	15.4	88.6	11.5	18 5	16.3	87.8
20 "	" 19	13.6	18.5	16.4	88.6	13.6	19 5	17 7	91.3
22 "	" 3	13 3	16.7	14.7	88 1	13.8	18 6	16 4	87.9
22 "	" 19	15.3	17.9	15 4	85 8	16.8	19.7	17 2	87.6
24 "	" 3	16 0	16.9	14.4	84.8	15 6	18 4	16.2	88.0
24 "	" 19	16.2	18 1	15.6	87 0	15 3	19.5	17 1	87.4
26 "	" 3	16 7	16.6	14.2	85.2	15.7	18.6	15.9	85.4
26 "	" 19	16 0	18.3	16.2	88.7	14 9	19.7	16.8	85.2
28 "	" 3	14.2	16.8	14.5	86.4	16.2	18.3	15.7	85.7
28 "	" 19	14.5	18.5	16.1	87.2	15 4	20.2	17.4	86.2

This year, there was very little rain through the latter part of September and early part of October, and last year the weather during the same period was uniformly wet, so that we have results from two different types of seasons. In all cases, the beets of one lifting were taken up without any rain, or other known circumstances, affecting the quality. In both years the beets taken at the earlier date were not as mature as those lifted later; but it cannot be said that the beets in rows closer together were any more mature than those in the rows a greater distance apart, nor did they mature more rapidly during the sixteen days between the two liftings. On the other hand, it is quite noticeable that in both experiments the average weight of the beets, tared as required for the factory, increased in weight with the wider distance between the rows. These experiments indicate that there is practically no difference in the quality of beets grown in rows 18 or 20 inches apart and thinned to eight inches in the row; but that there is a decided increase in the size of the beets as the distance between the rows is increased. Reference to the Report of the Experimentalists, however, shows that heavier yields are got the closer the rows are together. According to these results, it is apparent that the number of tons of beets that can be grown on an acre of land decreases as the distance between the rows is increased. In actual practice, the cost of cultivation of beets in rows 12 inches apart is greater than when there is a space of 28 inches between the rows. Just how far apart the rows shall be placed is, therefore, a question between cost of cultivation and yield of beets. With the cultivators now in use it is possible to conveniently cultivate between rows 18 inches apart, and this is the spacing usually recommended by those interested in the production of sugar beets for factory purposes.

Effect of Fertilizers on Sugar Beets.

Last year five quarter-acre plots of sugar beets were divided into two equal portions and one-half fertilized with Thomas Phosphate and the other half left unfertilized. The fertilized portion yielded over one ton of beets more per acre than the unfertilized, but there was practically no difference in the quality of the beets. This year Mr. Fulmer, one of our fourth year students, as part of the work on his graduation thesis, determined the effect of nitrogenous, potassic, and phosphatic manures and various mixtures of these manures on the quality and yield of sugar beets. The land used for this experimental

work was a clay loam and formed part of the field prepared in the usual way for turnips. It was in good condition, although no manure had been applied to this portion of the field for four years. Each plot was two rods long by one rod wide. The land was uniform and the stand of plants secured was almost perfect. The following table shows the fertilizers, the way they were combined, and the quantity of each used on the various plots. It also gives the results of the analysis of the juice and the yield per acre obtained when the beets were lifted on the 20th of October :

Composition of Sugar Beets.

No. of plot.	Manures.	Pounds per acre.	Analysis of juice.			Yield per acre.	
			Solids.	Sugar.	Purity.		
						Tons.	Lbs.
1	Farmyard manure	40,000	19.26	15.70	81.5	18	506
2	Mixture—						
	Sodium nitrate	80					
	Muriate of potash	120	20.06	17.15	85.4	16	399
	Superphosphate	320					
3	Sodium nitrate	240	19.46	17.05	87.5	17	273
4	Superphosphate	360	18 84	16 10	85.4	16	238
5	Muriate of potash	160	18.62	15.75	84.5	18	168
6	Mixture—						
	Sodium nitrate	160	20.02	17.45	87.1	18	763
	Muriate of potash	160					
7	Mixture—						
	Muriate of potash	160	19.82	17.25	87.0	19	156
	Superphosphate	320					
8	Mixture—						
	Sodium nitrate	160	19.22	16.90	87.9	16	584
	Superphosphate	320					
9	No manure or fertilizer	.....	20.12	17.55	87.2	15	346
10	Lime	2,400	18.82	15.75	83.6	17	229

The figures given above are the results of only one carefully-conducted experiment on one type of soil, and, therefore, cannot be supposed to apply to all kinds of soils. It is generally considered that farmyard manure has a tendency to force growth late in the season, and thus retard the ripening process. Reference to plots Nos. 1 and 9 shows that this contention is borne out in the experiment. The application of farmyard manure increased the yield by three tons per acre, but the percentage of the sugar and the purity of the juice are the lowest in the test. The plant food in the farmyard manure is rendered available comparatively slowly throughout the season. If the early part of the season be dry, and rains come in August and September, the conditions are at their worst, for then the farmyard manure and the moisture together tend to force growth at a time when the plants should be maturing. Nitrogenous manures force leaf and stem growth ; but, in plot No. 3, where sodium nitrate was applied, the beets were evidently well matured. In this case the nitrogen was available in the early part of the season, and the more rapid growth took place then. In this experiment, the application of muriate of potash increased the yield more than any other single fertilizer, in fact, almost as much as the farmyard manure. There was a greater increase when sodium nitrate was applied along with the potash, and a still greater increase when the two ash constituents, phosphoric acid and potash, were applied together ; but, when potash was left out of the mixture, the yield dropped considerably. It is evident, however, that potash alone does not tend to produce beets of high quality. As one of the actions of lime is to liberate potash in the soil, it is not surprising that the results obtained from its use correspond somewhat closely with those where potash was applied alone.

When sugar beets are grown on poor soil, the yield is usually low and the percentage of sugar high. When farmyard manure is applied in the spring, the ten-

dency is to increase the yield and decrease the sugar content. To obtain large yields of beets of good quality, it is essential that the land be rich ; but the farmyard manure should be applied with the previous crop. Wood ashes contain potash and phosphoric acid, and may be applied in the spring with good results.

Sugar Beet Pulp.

The pulp and waste molasses are the two main by-products of sugar factories. The former is the sliced beets, or "cossettes," after the sugar has been extracted ; the latter is the portion of the sugar extract left after the crystallizable sugar has been removed. The pulp is usually either flushed out of the factory with water or is passed through a strong screw press, where the water content is reduced to about 90 per cent. In this form it is a valuable cattle food, very similar in composition and food value to turnips. In the Berlin district particularly, the value of pulp as a cattle food is fuliy appreciated, and thousands of loads of it has been taken away by the farmers this season. One drawback to the value of pressed pulp is that it contains so much water that it cannot be transported long distances profitably. The difficulty has been recently overcome by drying the pulp at the factory. The first one of these drying plants operated in Ontario, and, I think, the second on the continent, was built by the Dresden Sugar Co., Dresden. All the pulp from the factory is passed through two powerful screw presses and then into the dryer, where the moisture is reduced to from 2 to 5 per cent. In this form it is bagged and stored away ready for shipment. They have also mixed the waste molasses with the pulp and dried the two together, making what they call "Molasses Cattle Food." The composition of dried pulp, and dried pulp and molasses, as determined in samples received from the factory this fall is as follows: as determined in samples received from the factory this fall is as follows :

Composition of Dried Pulp.

	Dried pulp.	Molasses cattle food.
Moisture	3.17	2.70
Ether extract	.73	1.46
Crude protein	7.69	8.81
Crude fibre	20.67	14.11
Soluble carbohydrates	61.71	66.58
Ash	6.03	6.34

The molasses had evidently improved the food value of the pulp. In the pressed form and in this new dried condition, sugar beet pulp is a valuable addition to the cattle foods of the Province. In order that we may have a fuller knowledge of the pulp, we will determine its digestibility this winter.

Sugar Beet Industry.

The past season has been a favorable one for sugar beet growers. It is true that in some localities the dry weather in the spring retarded germination and operated against the securing of a full stand of plants, but there was good growth during the summer, and the comparatively dry weather of the autumn allowed the beets to mature well, and rendered the work of harvesting more pleasant and less expensive than it was last year. The percentage of sugar in the beets sliced at the factories this fall will average over 15, while many carload lots have tested over 17. The purity of the juice, especially during the early part of the season, was very high. The only drawback to the full success of the factories this season was the scarcity of beets. The excessive amount of rain in 1902 and the extra labor this entailed in combating weeds on unprepared ground followed, as it was, by a wet, disagreeable fall, made many farmers unwilling to increase their acreage this year. The Ontario Sugar Co. will possibly have about two-thirds, and the Wallaceburg about one-half of a full campaign. The Wiarton and Dresden factories were particularly unfortunate in securing acreage, and, con-

sequently, had a very short campaign. However, the factories were able to commence slicing earlier, and have been in better running order this year. The beets being of better quality have also tended to improve matters for them. 'The Peterboro' Sugar Co., of Peterboro', commenced building operations rather late last spring, and when they found that the factory could not be completed this fall, sold the beets which they had under contract to the Wallaceburg Sugar Co. The experiment we conducted in the Peterboro' district in 1901 proved that sugar beets of very high quality could be grown there. This year's results confirm this conclusion, for the first 22 carloads shipped to Wallaceburg averaged 16.1 per cent. of sugar in the beets. The average for the whole season was 16.5 per cent.; 25 carloads went over 17, several reaching 17.8 per cent.

Regarding the question of whether farmers will continue to grow beets for the factories, I can only say that most of those who grew beets this year are exceedingly well pleased with the results. According to the terms imposed by the Provincial Government when the bonus was granted, the sugar companies were to pay a flat rate of $4 per ton for the first year, and $4 per ton for beets containing 12 per cent. of sugar, with 33 1-3 cents for each per cent. over 12 the second year. Thus, a farmer delivering beets containing 15 per cent. of sugar received $5 per ton. As this is the second year of the bonus, and 15 per cent. was the approximate average sugar content, it follows that the growers received this year about $5 per ton for their beets. In some instances beets were received at the factories rich enough in sugar to warrant the payment of nearly $6 per ton. With the practical knowledge gained from year to year in methods of preparing the ground, cultivating and harvesting the crop, and with the introduction of improved labor-saving machinery, it does seem as though the sugar beet is going to be one of the most profitable crops of the farm. The better methods of cultivation which are being introduced with this industry will also have a very beneficial influence on agriculture in general.

Uncompleted Work.

Besides the uncompleted work mentioned in the early part of this report, we are engaged on a study of the composition and digestibility of freshly-cut corn, as compared with that of corn cured in the field and in the silo. The corn crop of three different years has been studied, and the digestibility determined with sheep and cattle. This work is nearly completed, and the results will shortly be ready for publication.

Need of Increased Accommodation.

I desire to call your attention to the fact that the laboratories in the chemical building are altogether too small for the purposes for which they are required. In some classes two men work in the space originally intended for one, and in all the classes the men are too much crowded to do thoughtful work. I have had to let the specialists in chemistry and dairying work in the station laboratory, thus hampering our own analytical work. In view of these circumstances, and of the probability that the students of the Macdonald Institute will take chemistry with us, I beg to suggest that some addition be made to the chemical building this coming summer.

Publications.

The principal publications prepared this year were "The Report of the Sugar Beet Experiments in Ontario, 1902," pp. 32, and Bulletin 131, "Ripening of Cheese in Cold Storage," pp. 16. The first was prepared by myself, and the second by Prof. Dean and myself.

Respectfully submitted,

R. HARCOURT,
Professor of Chemistry.

December 31st, 1903.

PART VI.

THE LECTURER IN CHEMISTRY.

To the President of the Ontario Agricultural College :

Sir,—I beg to submit herewith a brief report of my work for the year ending December 31st, 1903:

Teaching.

During six months of this year my attention has been entirely concentrated on teaching. The ground covered was practically the same as that outlined in last year's report. It is, therefore, unnecessary to take up valuable space with a review of this work. I would like, however, to emphasize the importance of the lectures and laboratory work. As is well known, many of our young men come to the College with but a very elementary public school training. To such students the subject of Chemistry at first appears to be incomprehensible. Gradually, however, as the fundamental laws underlying the science are unfolded, the close relationship between it and practical agriculture is realized, and the student appreciates very greatly the value of even an elementary knowledge of the subject.

In teaching this subject, I have always found myself handicapped by insufficient equipment in the way of apparatus. It is necessary for the student to have a course of laboratory work to supplement the lectures. We hope, therefore, that a more liberal grant may be forthcoming, in order that this important branch of a scientific agricultural education may attain the highest degree of perfection.

The work of the dairy class is an important part of the teaching. In this, as in all our instruction, the practical side is emphasized. It is, perhaps, impossible to point to any specific number of cases where the good that a training in elementary chemistry for dairymen can be accurately measured. Yet, we are confident from the keen interest exhibited by the members of our dairy classes that the instruction given has not been lacking in good results.

The conduct of the student body in the class room has been excellent, and I am proud to say that the eager interest of our students in their studies has been a great source of satisfaction as well as a great incentive to me.

Investigations Undertaken.

Composition of By-products of Flour, Oat, Pea, and Starch Mills. The animal body is made up mainly of four classes of substances—water, ash or mineral matter, nitrogenous matter, and fat. The proportion in which these four classes of substances occur depends upon the age of the animal, its treatment, the purpose for which it is kept, etc. The substances of the body are continually breaking down and being consumed. To keep the animal in a healthy condition, there must be a constant supply of new material. If this is lacking or insufficient, hunger and finally death result. To keep up this supply is one of the chief uses of food, but in addition to this, the food supplies the heat of the body, and at the same time furnishes energy, which enables the animal to move the muscles and do work, both external and internal.

In addition to the above mentioned functions of foods, they also supply the immature animal with material wherewith to build up the tissues of the body. It will, therefore, be seen that to supply food in the right proportion to meet the requirements of the animal, without a waste of food nutrients, constitutes scientific feeding, and it is

by carefully studying the composition of feeding stuffs and the requirements of animals that a great deal of information may be obtained which would be of inestimable value to the practical agriculturist.

It was for the purpose of determining the composition of different by-products, and also determining the digestibility of the different foods that the work herein described was undertaken. We have been unable to secure the proper equipment, for carrying out this last mentioned part of the work, but we are in hopes that in the near future arrangements will be made whereby this very important line of research may be successfully carried on.

Throughout our Province are scattered a large number of mills which manufacture products such as bran, gluten meal, oat hulls, pea bran, etc. These products find thier market largely in Ontario, and, therefore, if we are able to give the buyer some idea of their relative feeding value, we shall have done something towards advancing scientific and practical agriculture.

The chemical analyses of the different by-products collected by us or furnished by the manufacturers during the past two years will be shown in a bulletin, which is now nearly ready for the printers. I may state that the methods of analysis followed were those of the Association of Official Agricultural Chemists. In addition to the chemical examination, the samples collected were subjected to careful microscopic examination, so far as time permitted. The chemical analysis gives valuable information as to the total quantities of important food materials contained in the feeding stuff. Certain by-products vary considerably in composition, according to the character of the season, methods of manufacture, etc., and unless they have an entirely abnormal composition, it is impossible to say with any certainty whether or not they are pure goods. It is, therefore, possible by putting in moderate quantities of foreign materials, especially if these do not vary much in composition from the by-product adulterated, to keep the chemical composition of the feed within such limits as not to give any positive evidence of adulteration. Since, however, foreign material in any feed can be readily shown under the microscope, the combined chemical and microscopic examination is almost certain to detect any adulterations. We can thus determine whether the seed used in the manufacture of oil was properly cleaned ; whether screenings, no matter how finely ground, have been mixed with mill feeds, and so forth.

Before discussing in a general way the results of the analysis of the samples of by-products, it might be advisable to explain briefly some of the terms used in discussions of the composition of feeding stuffs. In the ordinary chemical analysis of feeding stuffs the following components are generally determined : moisture, protein, fat, crude fibre, ash, and nitrogen-free extract. Taking these in order we note :

1. That moisture (water) is found in varying quantities in all foodstuffs. A high water content in a concentrated foodstuff is a decided detriment. First, because it diminishes the percentage of actual food material, and, second, because it causes the food to mould or turn sour sooner than if less moisture is present.

2. Protein (or nitrogenous material) constitutes the flesh-forming materials of the food. It furnishes the materials for lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool and the casein and albumen of milk, etc. For these purposes protein is absolutely indispensable in the food of animals. No substances free from nitrogen can supply protein.

3. Fat (or ether extract) is the portion of the food which is dissolved from the water-free substance by ether, benzine, gasoline, etc. It is a very important component of feeding stuffs on account of its high value for the production of fat, energy and heat.

4. Crude fibre is a term applied to a group of substances that are of very limited value to the feeder, being not only largely indigestible, so that the digestive juices of the animal do not extract much nutriment from them, but, what is still more important, rendering the rest of the food less digestible by protecting it from the action of digestive fluids.

5. Ash is the non-combustible or inorganic portion of feeding stuffs. Some of the foods richest in protein are also rich in ash materials, and, therefore, of high manurial value.

6. Nitrogen free-extract is that portion of the food which is dissolved by boiling with dilute acids. It consists mainly of starches and sugars. When taken into the system nitrogen-free-extract forms fat or is oxidized to produce heat and energy.

Having thus seen the function of food, and knowing the meaning of the different terms used, we may give a brief review of some of the results obtained, in order to make the work as practical as possible. It has been mentioned that some of the foods richest in protein are also rich in ash material. The result of our work shows that an exception is formed by concentrated feeds, which are by-products, where the seeds are treated with large quantities of water, as in the manufacture of starch and glucose. Such foods should be fed with caution to calves and young stock that consume but little roughage and require a liberal supply of ash material for the formation of bone.

A high percentage of protein is found in the refuse feeds from oil mills, glucose factories, distilleries, breweries, and flour mills. In these various manufacturing establishments the starch or oil has been removed from the grains, and is used for the production of human foods or other commercial articles. The residue is, therefore, very rich in protein. As crops grown on the farm are likely to be deficient in protein, it is important, as a rule, in purchasing feeds to supplement farm-grown crops, to obtain as much protein as possible. Other things being equal, the richer the food is in protein, the more valuable it is to the farmer, that is, if it is of such a character that it can be fed to the animals kept.

In our work we have found the greatest amount of crude fibre in such by-products as oat hulls, corn bran, and similar materials. These possess but a very low feeding value. They may, however, in some cases, have a beneficial mechanical effect, in making a food lighter and thus aiding digestion. Such a food as ground corn is materially benefited by adding to it oat hulls, barley, bran, or some such product.

Our examination of wheat bran, middlings, and other by-products from the flour mill shows that the components of these foodstuffs may vary widely; but it is gratifying to know, on account of the importance and wide use made of these materials, that the quality of the samples examined has been found to be excellent. The only adulterants we were able to detect were particles of flour and whole screenings.

In closing the review of this line of investigation, I wish to emphasize the following points :

1. The value of a food depends to a great extent upon the proportion of digestible food material found therein; but two other factors enter in, namely : first, the amount of work which the animal has to do in digesting the food ; and, second, the time. The first factor is, under normal conditions, by far the more important. If the food fed the animal requires more energy on the part of the animal to digest it than this can furnish the animal, the animal must take from its own body substance in order to live. If, therefore, such materials as straw, chaff, etc., be fed in considerable quantity, they not only do not supply much nutriment themselves, but reduce that furnished by the rest of the food. The admixture of large quantities of such materials as oat hulls, corn bran, etc., to concentrated foods is, therefore, a positive detriment, in so far as the utilization of other portions of the food is concerned. A moderate use of these refuse feeds, as previously stated, is justifiable and sometimes advantageous.

2. The narrow margin which producers are often compelled to take on beef, makes it absolutely essential that the feeder should take advantage of every means within his power, in order that he may place his animals on the market at the least possible cost. To do this he must be familiar with the relative values of the different foods upon the market. It is, therefore, our duty to supply farmers with as much information as possible on this very important subject.

3. The laws which govern the formation of flesh, fat, etc., are not fully established. Therefore further investigation along this line is of much importance.

4. Chemical analysis has shown that many of our by-producets are rich in valuable food components. Before, however, we can place any relative value on them, it is necessary that we should know to what extent the animal is able to digest them. We hope to be able to carry on this line of investigation, as we believe that data can be obtained which will be of the highest importance to feeders of live stock.

A Study of the Chemical Changes Which Take Place in Cheese During the Ripening Process.

The question of the chemical changes which take place in cheese ripening is a very important one, and one which, for the past three years, has received considerable attention from the Chemical Department of the Ontario Agricultural College. The work of investigating the conditions which affect these changes was commenced by Prof. Harcourt in 1900, and has been carried on continuously through a period of two and one-half years.

I shall now give you a brief summary of our work, and where possible shall point out conclusions which may be of practical value to dairymen. In our first series of experiments we endeavored to discover the influence which "time" has upon the ripening process. From data obtained in this series of experiments, we are led to believe that the amount of soluble nitrogenous compounds increases as cheese age. The rate of the formation of these compounds is more rapid in the early stages of ripening, about 5-8 of the total soluble nitrogenous compounds being formed during the first three months and over 90 per cent. in the first eleven months of a two years' period of study.

The Effect of Different Temperatures on Cheese Ripening next engaged our attention. Prof Dean and his able staff rendered us every assistance in this work, as in all other lines of investigation undertaken in relation to dairy products. Several series of cheese were made in duplicate. One of each pair marked A was placed at once in cold storage. The second, "E," was placed in the ordinary curing room. These cheese were analyzed every month, and the data obtained indicate that soluble nitrogenous compounds increase in cheese ripening quite closely in proportion to increase of temperature. The cheese in the ordinary curing room at two weeks old showed a much higher percentage of soluble nitrogenous compounds than those in cold storage. At a month old the rate of ripening was practically the same in both cases, and at the end of six weeks the cheese in cold storage showed a slight increase in the percentage rate of ripening over the cheese cured at ordinary temperatures. The amide and ammonia compounds, however, were more abundantly formed, and they steadily accumulated in the cheese at higher temperatures.

The influence which salt exerts on the development of soluble nitrogenous substances in cheese was next studied. This part of the investigation proved very interesting, as our results go to show that in cheese containing a high percentage of salt (3 per cent. or over) the soluble nitrogenous compounds are formed more slowly than in cheese containing less salt. This would appear to be due, in part, to the direct action of salt in retarding the activity of one or more of the ripening agents, and, in part, to the tendency of salt to reduce the moisture-content of the cheese.

The moisture-content affects, in a marked degree, the percentage of soluble nitrogen in cheese. Co-operating with the Dairy Department, we studied each experiment carefully, and found that after a period of one month had elapsed the cheese with a higher moisture-content showed a correspondingly higher percentage of soluble nitrogenous substance. I may state that in the manufacture of the cheese used in this experiment, great pains were taken to incorporate as much moisture as possible in one cheese, and to expel the excess of moisture from the second. Prof. Dean made the determinations of moisture and salt. The soluble nitrogen was determined in the chemical laboratory. The first analysis was made immediately after the cheese were removed from the hoops, and the second when the cheese were three weeks

old. Other analyses were made monthly. The results obtained from this series of experiments show that cheese containing more moisture, other conditions being uniform, generally contains larger amounts of soluble nitrogenous substance, especially after the early stages of ripening. There are two reasons why moisture may affect the ripening process in cheese. First, moisture in itself favors the activity of ripening ferments, and, second, the presence of increased amounts of moisture serves to dilute the fermentation products that accumulate.

In the experiments conducted, we made very careful determinations of the various forms of nitrogen in the cheese, namely paracasein, caseoses, peptones, amides, and ammonia. The data secured shows that the first three of these nitrogenous compounds usually vary within narrow limits, and do not as a rule accumulate in cheese in increasing quantities, but after a time decrease. On the other hand, amides and ammonia are found to accumulate continuously during the normal ripening of the cheese. The cold-cured cheese always showed an increase of paranuclein, caseoses, and peptones, while in the cheese cured at high temperatures, we always found a high percentage of amides and ammonia. It is not improbable that the off-flavors sometimes noticed in cheese cured at high temperatures may be to some extent due to the accumulation of these end products (amides and ammonia).

There is one fact mentioned in the early part of this discussion which I should like to repeat, namely, that over 90 per cent. of the soluble nitrogenous substances is formed within the first eleven months. This would appear to indicate that the products of proteolysis in some way affect the chemical activity of the micro-organisms and ferments which bring about the changes. In other words, the accumulation of soluble nitrogenous compounds in cheese appears to diminish the activity of the proteolytic agents, and this in a measure explains the reason why cheese ripen less rapidly after the first period. We all know that when milk casein and its salts, or paracasein and its salts, are acted upon by dilute acids or alkalies under certain conditions, or by enzymes or micro-organisms, the proteid bodies are split up, and thus give rise to a variety of cleavage products already mentioned. The accumulation of these products in cheese is what is commonly called ripening. In the green cheese nearly all of the nitrogenous substance is in the form of paracasein and its salts. As the cheese ripens, the paracasein and its salts are broken down into caseoses, peptones, etc., but when these latter accumulate to a certain point their presence renders inert the agents to which they owe their existence.

In closing this discussion on this line of our work, permit me to point out a few practical considerations which may be gathered therefrom: (1) That high temperatures in ripening promote rapid development of soluble nitrogenous compounds, some of which are undesirable. (2) That cheese with a higher moisture-content ripens more rapidly, but rapid ripening is not conducive to the production of cheese of the best quality. (3) That the ordinary amount of salt used in the manufacture of cheese does not materially affect the ripening process, but a high percentage of salt retards the development of soluble nitrogenous compounds. (4) The conditions of the manufacture of cheese and of ripening determine the rapidity and extent to which chemical changes take place in nitrogenous compounds after ripening. (5) That cheese made and handled so as to ripen slowly is of a higher commercial value.

To these remarks I may add that Dr. Van Slyke has found that increased amounts of rennet favor the development of the valuable nitrogenous compounds in cheese during the ripening process.

The Use of Preservatives.

As yet no work hs been done by our college to indicate the relative merits of the different forms of preservatives placed upon the market. The question of preservatives is a live one at the present time, and deserves more attention from us. During the

past season, few if any of our manufacturers shipped any butter to the British market which did not contain one or other of the preservatives. It is now a recognized fact that if we are to compete with other nations in supplying butter to the British market some form of preservative must be used. The use of small quantities of such a chemical compound as boracic acid does not necessarily mean that the butter is unfit for domestic use. As a matter of fact, this preservative does not injure the flavor in any way, and it improves the keeping qualities very materially.

Miscellaneous.

We had a number of samples of water sent from different districts by dairymen to be examined for impurities. In several cases the result of chemical examination showed the presence of sewage contamination. It might not be out of place, therefore, to utter a word of warning in this connection. Sewage contaminations frequently carry along with them germs of typhoid, cholera, and other diseases. It is, therefore, advisable to have water suspected of containing contaminations of any kind examined; and if these be found, steps should be taken to have the wells filled in.

The analytical work necessary to determine whether a water contains sewage contaminations requires great skill, and the conclusions drawn from the results are not fully agreed on by scientific chemists. There are, however, a number of simple tests that may very often determine whether it is worth while to perform a more elaborate analysis of the water. As these tests are very simple, and can be performed by anyone of an ordinary degree of intelligence, it may not be out of place to mention them. I think they may prove helpful to dairymen in their work.

Tests: (1) Pour half a pint of water to be tested into a wide mouthed bottle or decanter; close it with the palm of your hand, or, better, with a glass stopper; and shake it violently up and down. If an offensive odor is then perceived, the water is probably contaminated by sewage gas, and possibly with other constituents from the same source.

(2) Add to a little of the water a drop or two of dilute sulphuric acid, and enough potassium permanganate to tinge it to a faint rose color; cover the vessel with a saucer or glass plate. If the pink tinge is still visible after a quarter of an hour, the water may be considered wholesome.

(3) Pour a little solution of silver nitrate into a carefully cleaned glass and see that it remains transparent; then pour in some of the water; should a strong milkiness appear that is not cleared up on adding a little dilute nitric acid, the water probably contains sodium chloride, which always exists in sewage water, but very seldom in wholesome water in any considerable quantity, unless near the sea coast.

Alkaline Solution.

During the past season we shipped 178 gallons of standard alkaline solution to dairymen throughout the Province of Ontario. The alkaline solution has replaced, to a certain extent, the hot-iron in testing the acidity of whey, curd, etc., in cheese-making. The value of this test has been pretty clearly demonstrated; and I think the time has come when the manufacture of the standard solution should go into the hands of commercial men. So long as the value of this test was in doubt, it was clearly our duty to assist the dairymen to the extent of manufacturing a reliable solution for them; but the time has come when there is no longer any doubt regarding its value. I would, therefore, recommend that the manufacture of the alkaline solution be discontinued at the College.

All of which is respectfully submitted.

W. P. GAMBLE,
Lecturer in Chemistry.

PART VII.

THE PROFESSOR OF VETERINARY SCIENCE.

To the President of the Ontario Agricultural College :

Sir,—Allow me to submit my report for 1902-1903 :

Class Room.

The class room work in the forenoons was much the same as in former years ; but we spent more time and gave more attention to practical work during the afternoon periods.

First Year. During the fall term I gave to this class a course of lectures and demonstrations on comparative anatomy. This included a brief, but comprehensive consideration of the skeleton, joints, and muscular system ; the digestive, respiratory, urinary, and generative organs ; the circulatory and absorbent systems, the eye, skin, and foot. We studied principally the anatomy of the horse, having the skeleton and the individual bones of this animal and also a living animal in the class room during lectures. Where important differences exist between the anatomy of the horse and the ox, the attention of the class is drawn to them.

During the afternoon periods, we discussed the erection of horse stables, as regards site, material, ventilation, drainage, kinds and arrangements of stalls, both single and box, feed boxes, mangers, floors, etc.; likewise the general care of horses as regards feeding, watering, grooming, handling colts, educating them to drive, working or exercising them, etc. ; and the care of harness, saddlery, carriages, etc. In addition to the above, I gave a course on judging horses. In this we are handicapped in not having the different breeds and classes in the stables of the institution. I select for demonstrations the best we have, borrow some, and supply some from my own stable.

During the winter term, I delivered a course of lectures on Veterinary Materia Medica, in which I spoke of the properties, actions, uses, and doses of medicines and remedies used for the prevention and cure of the ordinary diseases to which farm stock is subject ; we also discussed the different methods of administering and applying medicines, with the advantages and disadvantages of each.

Second Year. The fall term class room work for this year consisted in the consideration of the causes, symptoms, and treatment (both preventive and curative), of the ordinary diseases of farm stock, with frequent reference to the proper mode of feeding, watering, and general care of stock in order to prevent disease. During lectures, I usually have one of my own horses in the class room and explain the different appearances between a healthy and a diseased animal. In speaking of the diseases of bones, joints, muscles, eyes, skin, feet, etc., I point out on the healthy animal the seat of disease, and explain the changes in structure and appearances produced by the disease. I also have specimens of diseased bones, and when speaking of the diseases of bones I am thereby enabled to show the class the changes of structure that take place as the result of the disease.

During the winter term, I gave a course of lectures on veterinary obstetrics, treating of the phenomena of reproduction, the usual causes of sterility, and the way by which some of them can be removed ; the diseases of both sexes due to the act of reproduction, the general hygienic treatment of pregnant females, the development of the foetus, the phenomena of parturition, the manner of treating ordinary cases of difficult

parturition, with the causes that produce such ; the causes, symptoms, and treatment of the diseases of both dam and offspring, incident to and following parturition, and give special attention to the care of the young. As far as possible, I illustrate these lectures with charts.

In the afternoons, I gave a course of lectures and demonstrations called "Practical Horse," in which I demonstrated with a living horse, the best methods of securing an animal for minor operations, such as opening abscesses, dissecting out tumors, dressing and stitching wounds, firing for spavin, ringbone, and kindred diseases, the different methods of castration, etc. I illustrated the different methods of applying bandages, stitching wounds, dressing and extracting teeth, scarifying lampas, passing a probang in the horse and ox in case of choking, puncturing an ox in case of excessive bloating, etc. In addition to the above, I gave a course in horse judging. As with the first year, we have difficulty in securing even fair specimens of the different breeds and classes. We have in the farm stables a few specimens of the agricultural horse. I supply from my own stable fair specimens of saddle horses and hunters ; for the other classes, I borrow or take the class to the farms of local breeders.

Third and Fourth Years. To these classes, I gave instructions on judging horses, following the same plan as with the first and second years.

Special Classes. Two special short courses (of two weeks each) in stock judging were given ; one in January, which was attended by about 250 farmers and farmers' sons, and one in March, attended by about 40 Farmers' Institute workers. During the latter course. I was ably assisted by Dr. Quin of Brampton. The erection of the judging pavilion for this purpose made the facilities as complete as possible. Here again the want of horses suitable for the purpose was keenly felt, and freely commented upon by those in attendance. I secured suitable animals from the citizens of Guelph, local dealers, breeders, and farmers. I wish to take this opportunity of publicly expressing our gratitude for the kindness of the following gentlemen in providing subjects for comparison and discussion, viz., Messrs. Sorby, McCannell, Hurley, Atchison, Stewart, Tovell, Smith, and Tyson. As a matter of course, horses brought before a class of this kind are subjected to severe criticism, and are not always placed just where their owners think they should be in a class. There is no point upon which the average horse owner is so sensitive as he is regarding the quality and merits of his high class horse ; and while we had many horses of this kind, it was noticeable that, while severely, and in some cases unjustly criticized, the owners took it all in good part. Unfortunately, this is not always the case ; but we endeavor to avoid any unpleasantness by asking favors of this kind from those whom we think will not be over-sensitive. The members of both classes expressed themselves as being highly pleased, both with the object of the classes and the manner in which they were conducted.

I would like to draw the careful attention of the Department to the points already noted, viz., the lack of horses suitable for class room purposes, even for the regular classes. We have not a pure-bred horse at the institution, nor even a fair representative of any class other than the ordinary work or agricultural horse. For the special classes, it is possible to borrow ; but for the regular classes, this is impracticable, as we cannot expect outsiders to be continually supplying us. While, even under existing conditions, the results where our students have entered into competition with students of other colleges and the general public, in judging competitions at fairs, have proved that our efforts have not been in vain, much better results would doubtless be noticed if we had even a few typical animals. We realize that it would entail considerable expense to provide a number of each recognized breed and class ; but might we not get a stallion and two or three mares of, say, Clydesdales or Shires and Hackneys at first, and gradually increase the classes ? The stallions could do stud service, and thereby assist in reducing expenses. This would gradually bring the facilities for giving instruction in horse judging on a par with that which exists in the other classes of stock.

Diseases and Ailments in Stock.

Besides class room and practical work, I gave professional attention to all the stock of the institution, and am pleased to be able to state that the losses were few.

Horses. We had a few cases of the ordinary diseases in horses, viz., colic, acute indigestion, lymphangitis, influenza, wounds, calks, bruises, broken knees, sore shoulders and necks, eczema, oedema, etc., all of which recovered. We had a fatal case of acute indigestion, quickly followed by rupture of the stomach in a mare belonging to the gardener's department. This is the first fatal case of illness in horses that has occurred during the eleven years that I have held my present appointment. A mare belonging to the experimental department that was successfully treated for ringbone five years ago again went lame this fall. I fired her in the class-room in the presence of the second year class ; but, as she is old, it is doubtful if the operation will prove successful.

Cattle. We had a case of parturient apoplexy, several of difficult parturition, retention of the placenta, mammitis, sore teats, indigestion, impaction of the rumen, fardel bound, uterine discharge, and other ordinary diseases, all of which yielded to treatment. We had one case of lump jaw, for which the iodide of potassium treatment was used ; this consists in administering 1 dram of the drug three times daily and gradually increasing the dose until the patient shows symptoms of iodism (poisoning by iodine), which are, refusal to take food or water, slavering from the mouth, and discharge from eyes. When any of these symptoms appear the administration of the drug must stop, and, if necessary, treatment may be repeated in 3 or 4 weeks. In the case mentioned, treatment arrested the disease ; but, as the bone was considerably enlarged, the growth did not entirely disappear.

Sheep. We had little trouble with our sheep. We had one fatal case of inversion of the uterus in a ewe, and two or three fatal cases of wood balls in the stomachs of lambs.

Pigs. In the experimental piggery we lost a few pigs from pneumonia; otherwise we had no losses, except a few newly-born ones.

I have the honor to be

Your obedient servant,

J. H. REED,
Professor of Veterinary Science.

PART VIII.

THE PROFESSOR OF DAIRY HUSBANDRY.

To the President of the Ontario Agricultural College :

Sir,—I beg leave to submit my thirteenth annual report of the Dairy Department of the College. The year has been a successful one in many respects. Our milk supply is steadily increasing, and we now have sufficient for our Dairy School and for experimental work. Mr. McFeeters, our buttermaker, left the dairy at the close of the Dairy School term, to act as one of the instructors in buttermaking for the Western Dairymen's Association. His place was taken for the remainder of the year by Harry Rive, B.S.A. Mr. Stratton continued in charge of the experimental cheese work, and supervised the dairy work generally. I am specially indebted to Mr. Stratton for his good work during the past year. Mr. Witter also, who has charge of the dairy herd, has done excellent work.

During the year, a carbonic anhydride ice machine was installed at the dairy. While the results, during the past season, have not been so satisfactory as we expected, we are hoping for better results next year. The machine is somewhat expensive to run, and is rather delicate in construction for the average buttermaker to operate. While it is working, it does good service, but the chief difficulty consists in preventing the leakage of gas. Owing to the high pressure to which the gas is subjected, it seems almost impossible to prevent it leaking from the valves, joints, etc., connected with the system.

Our herd is larger at present than at any time during the past thirteen years. However, several of the cows will be sold for beef early in 1904, owing to failure to breed, or other causes, which make them likely to be unprofitable as milkers. We have representatives of three breeds—Holsteins, Ayrshires, and Jerseys. We are culling out the poor cows and aiming to increase the standard of production all the time. Three Holstein heifers and one Jersey bull calf were sold at the College sale, held in the autumn.

During the coming year, we should like to place cement floors in several parts of the dairy building and also in the dairy stables. We should also like to instal an electric motor at the dairy barn for cutting feed, etc., and one in the dairy building for running the buttermaking machinery. The rope drives used in the past are very unsatisfactory.

The Dairy Department has furnished to the College, during the year, milk and cream to the value of about $1,200.

A course of lectures and practical work was given to the College students of the first, second, and fourth years.

The Dairy School.

The various sessions of the Dairy School were well attended during the year. The regular school, held during January, February, and March, was attended by 88 students. In addition, 46 ladies registered for the special Domestic Science lectures, so ably given by Miss Helen Given, of Hamilton, to the young ladies of the dairy class.

A special ten days' session was held for instructors employed by the Western Dairymen's Association, as well as for others who might wish to qualify for the work. The number attending this course was sixteen. Mr. J. A. Ruddick, Chief of the Dairy Division, Ottawa, very kindly assisted with lectures for this class.

During the summer, twelve students took practical work in the dairy. In the month of December, the special creamery class was attended by ten buttermakers—nearly

all experienced men. It will thus be seen that we have students in attendance at the dairy practically the whole year. The total attendance at the Dairy School, exclusive of the regular College students, and including the Domestic Science class, was one hundred and seventy-two.

We are aiming to improve the Dairy School courses each year. More attention is now paid to experimental work with advanced and experienced students. Many of our students know the routine of cheese and buttermaking, but are much interested in making experiments along various lines. To do this work effectually, separate rooms, and special sets of apparatus ought to be provided, as well as instructors who have had special training as experimenters. However, we have made a beginning and hope to improve in methods and apparatus as we gain experience. This feature of dairy teaching is likely to be the most effective yet adopted. This was especially noticeable in the creamery class during December, when experiments in the pasteurization of sweet and ripe cream and with the various kinds of hand separators, proved very interesting and profitable to the class.

We are indebted to the instructors for their valuable co-operation and help, to Professors Harrison and Gamble for bacteriological and chemical assistance, and to several of the College professors for aid in lectures during the school term.

EXPERIMENTAL WORK.

Market Milk.

The importance of pure and wholesome milk for household purposes is recognized by all. Every Canadian home is interested in pure milk for table use. During 1902, a series of experiments was conducted relating to this question. This year, a similar series was carried on in the months of July, August, and September. A portion of the milk was from our own herd; but for the majority of the experiments, the milk was that supplied by regular patrons of the Dairy Department. This milk would, therefore, more nearly resemble the milk sold in towns.

The milk in each experiment was divided into from six to eight different lots. Samples were placed in sterilized bottles,—marked Normal, Clarified, Pasteurized at 140 degrees F., Clarified at 140 degrees F., Pasteurized at 160 degrees F., Clarified at 160 degrees F., Pasteurized at 180 degrees F., and Filtered. The samples marked Normal were from the milk as delivered by the patrons. The Clarified samples were run through an Alpha De Laval separator at ordinary (90 to 95 degrees) temperatures. The Pasteurized samples were heated at 140, 160, and 180 degrees in a Danish pasteurizer, while samples at temperatures of 140 and 160 degrees were also run through an Alpha separator. The Filtered samples were run through cotton-batting filters, which were used but once and then destroyed. The lots were then placed in cold storage at a temperature of about 40 degrees for twenty-four hours, when they were brought into the butter room of the dairy for two to four hours, where the temperature ranged from about 60 to 85 degrees, and were scored. Usually the samples were put back into cold storage for another twenty-four hours ; but sometimes they were left in the butter room until the second scoring, which took place twenty-four hours after the first. At the end of this time, the samples were scored according to the following scale : Smell, 20; taste, 25; acidity, 35; cream, 15; appearance, 5.

The acidity was ascertained with an acidimeter and the scoring was made on the following basis :

Milk containing less than .15 per cent. acid received 35 points.
Milk containing .15 per cent. acid received 34 points.
Milk containing .16 per cent. acid received 33 points.
Milk containing .17 per cent. acid received 32 points.
Milk containing .18 per cent. acid received 31 points.
Milk containing .19 per cent. acid received 30 points.

Milk containing .20 per cent. acid received 28 points.
Milk containing .21 per cent. acid received 26 points.
Milk containing .22 per cent. acid received 24 points.
Milk containing .23 per cent. acid received 22 points.
Milk containing .24 per cent. acid received 20 points.
Milk containing .25 per cent. acid received 18 points.
Milk containing .26 per cent. acid received 15 points.
Milk containing .27 per cent. acid received 12 points.
Milk containing .28 per cent. acid received 9 points.
Milk containing .29 per cent. acid received 6 points.
Milk containing .30 per cent. acid received 3 points.

Above .3 per cent. acid, no points were allowed.

The Acidity of the Samples. The following table shows the percentage of acid, reckoned as lactic acid, which developed in the samples at the end of twenty-four and forty-eight hours. The striking point, is the small amount in all the samples which were heated to 180 degrees. The highest amount of acid at the end of forty-eight hours was but .27 per cent. Some of the samples heated to 160 degrees developed a high acidity at the end of forty-eight hours, although they were all good up to twenty-four hours. The average of all the pasteurized lots was within the limits of market milk.

	Percentage of acid at end of 24 hours.			Percentage of acid at end of 48 hours.		
	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.
Normal	.47	.17	.27	.90	.20	.51
Clarified	.39	.16	.24	.88	.19	.50
Past. 140	.21	.15	.18	.80	.16	.24
Clar. 160	.25	.16	.18	.80	.17	.27
Past. 160	.19	.15	.17	.82	.15	.22
Clar. 160	.20	.15	.16	.78	.16	.22
Filtered	34	.18	.25	.91	.20	.52
Past. 180	.17	.10	.15	.27	.13	.16

Results of the Scoring. The following table shows the average of first and second scorings in the eight lots of milk. It will be noticed that there was not much difference in the lots at the first scoring, except for acidity. The pasteurized lots received a higher scoring at both times for acidity ; in other words, the heating caused the samples to remain much sweeter. On the other hand, the depth of cream was much less, especially on those samples heated to 160 and 180 degrees. In some cases, where the samples were cooled to 40 degrees immediately after heating, the cream rose fairly well, but this was not so in every case.

	Smell max. 20.		Taste max. 25.		Acidity. max. 35.		Depth of cream. max. 15.	
	Av. 1st S.	Av. 2nd S.	Av. 1st S.	Av. 2nd S.	Av. 1st S.	Av. 2nd S.	Av. 1st S	Av 2nd S.
Normal	16.8	11.7	20.8	11.5	17.	10.4	14.3	13 9
Clarified	16 8	12.8	20.7	11 5	20.1	8.2	12.	11.8
Past. 140	18.	13 7	23.	17.3	30.7	27 3	12.	10.7
Clar. 140	17.6	13.6	22.5	16.9	30.4	25.1	10.9	10 8
Past. 160	18.9	15.9	23.6	19.	31.9	29 6	8.4	8.3
Clar. 160	18.7	15.8	23.1	18.8	32.	28.7	8.4	8 8
Filtered	18.1	9.1	22.	10.1	16.2	9.3	12.2	12.2
Past. 180	18.2	17.	23.2	21.	33.4	31.1	7.5	7.8
Average of all	17.8	13.7	22.3	15.7	26.4	20.5	10.7	10.6

Average of all the Scorings. When we average all the results, the lots heated to 140 degrees stand first at the end of twenty-four hours. At the end of forty-eight hours, the lots heated to 180 degrees stand first. The clarified lots scored lower in every case than the lots not run through a separator, when both were under the same conditions of temperature. Filtering the milk added very little to the quality as shown by the scoring:

Kind.	Average 1st score Max 100.	Average 2nd score, Max. 100.
Normal	72.6	39.9
Clarified	71.7	34 9
Past. 140	88.5	73.2
Clar. 140	85.5	66.9
Past. 160	87.6	76.4
Clar. 160	86.3	75.
Filtered	73.4	40.2
Past. 180	87.	80.2
Average of all	81.57	60.83

Conclusions. Milk which is consumed inside of twenty-four hours after delivery to the dairy company or retailer will probably give best satisfaction if heated to about 140 degrees and afterwards cooled to below 50 degrees. However, for hot weather and for average conditions of delivery, the best results are got by heating to 160 or 180 degrees, and then cooling to about 40 degrees. Where the milk is produced under the most sanitary conditions, heating will not be necessary. Cooling such milk to 40 degrees will secure milk in possibly the best condition for household purposes. This plan is not likely to be adopted except on a limited scale, and such milk usually sells for a high price. For average town trade, especially by dairy companies, the heating and cooling is possibly the best method to adopt, as it checks the development of lactic acid; or, in other words, it prevents the souring of the milk, produces milk with a cleaner flavor, and tends to destroy disease or other bad germs which may be in the milk.

The results confirm those obtained last year regarding clarifying, or running milk through a centrifugal machine. The only advantage seems to be to remove dirt from the milk. It seems to not improve the flavor, etc., but rather lessens its value. Filtering also appears to be of doubtful value, except to remove dirt.

Testing Cream.

Oil Test vs. Babcock Test for Cream.

This is a continuation of the work done in 1902. Six experiments were made, a vat of ripened cream being used in each case. Duplicate samples of cream were taken for both tests. The percentage of fat in the cream ranged from 31.5 to 35.5 and averaged 33.29. The oil-test ranged from 150 to 170, and averaged 156.75. In the six experiments, 305.6 inches of cream weighing 1,270 pounds were used. The average pounds of cream per creamery inch were 4.15. The estimated yield of butter by the oil-test was 479 pounds. The actual yield was 502 pounds. The "overrun" on the oil-test averaged 4.62 per cent., while that on the Babcock test for fat averaged 18.6 per cent. In each experiment, the churn yield was greater than that called for by the oil-test churn. This increase varied from half a pound of butter to over eight pounds on an average-sized churning of 51 inches of cream.

Conclusion. The oil-test is not a very reliable test for dividing proceeds of sales of butter among patrons who deliver cream, and should be superseded by the Babcock test as soon as the change can be conveniently made. It is better, however, for creamerymen not to make the change without explaining to patrons why the change is made, and how it is likely to affect the results to them, thus avoiding suspicion and loss of patronage.

Buttermaking.

Cultures for Buttermaking.

The flavor of butter made from pasteurized cream depends almost entirely upon the character of the culture, commonly known as "starter," used in ripening the cream. The butter made in the Dairy Department of the College is made from cream which has been separated from milk heated to about 185 degrees F., before separating. This plan has proved very satisfactory ; it has given us a uniformity in the product which can be got in no other way. As previously stated, however, such butter depends nearly altogether for flavor upon the character of the culture or ripening medium. This being so, we are naturally on the lookout at all times for an improved culture.

Through the courtesy of Prof. Harrison, of the Bacteriological Department, we have been supplied during the past year with excellent cultures. In the latter part of September and the fore part of October, seven tests were made of a German culture compared with our ordinary lactic acid culture. Prof. Harrison gives the following bacteriological data of the cultures : "The culture consisted of the lactic acid organism which we are sending out to cheese factories and creameries, together with a culture of a mould of Oidium lactis. This mould was discovered by Dr. Weigmann, of the Experiment Station and Dairy Institute of the Province of Schleswig-Holstein, Germany. Dr. Weigmann informs me that this organism does not give such a pleasant taste and odor as it formerly did, but even now favorable results may be had from its use. The culture supplied to the dairy was perfectly pure, containing only the lactic acid bacillus and the Oidium. The culture that you compared it with was one of the lactic acid organisms that you have been using in the dairy during the past season."

The tables show the scorings of the lots of butter made by using the two cultures. As will be seen from the results, there was little or no improvement in the quality of the butter from using the German culture. The butter, when first made, had a more pronounced flavor than did the butter made by using the ordinary lactic acid culture. However, the aroma was not so pleasant, and it seemed to go off in flavor more quickly than did the butter made by using our ordinary culture. The flavors were so different when first made, that it was difficult to decide whether or not the butter made by using the German culture was any improvement. On the whole, we decided that there was little or no improvement in flavor, and that we got better results from using the ordinary lactic acid culture in the pasteurized cream. This was specially so when keeping quality was considered.

Sample No.	Flavor (Max. 45.)	
	College Laboratory.	German.
22 Average of all	42.	41.6
23 "	41.6	42.
24 "	42.	40.6
25 "	42.	38.5
28 "	42.	40.5
29 "	42.	41.5
4 "		42.
Average of 1st score	42 6	42.7
Average of 2nd score	41.5	39.8
Average of 3rd score	41.3	40.
Average total 1st score	97.6	97.7
Average total 2nd score	96.5	94.8
Average total 3rd score	96.3	95.

Cold-Storage for Butter.

The object of the following experiments was to determine, (1) the relative advantage of ice and mechanical cold-storage for holding butter; and (2) whether or not it is best to put butter directly into a low temperature or to place it in a moderately cold room for a short time, and then move to a colder temperature.

Ice vs. Mechanical Cold-Storage. During July, August, and September, ten 28-pound boxes of butter were made on five different dates, from five different churnings. One of these boxes on each date was placed as soon as made in the Hanrahan ice cold-storage. The other from the same churning was placed in one of the compartments of the mechanical cold-storage. The temperature in both places ranged from 38 to 40 degrees. The lots of butter were scored the first time in from one to two weeks after being made. The second scoring was made one month later, and the third about three months after the butter was made.

There was not much difference in the quality of the different samples at the first scoring: but at the second and third scorings, there was a slight difference in favor of the lots in the mechanical cold-storage. The average of all the scores for flavor was 38.9 out of a possible 45 for the lots in ice cold-storage, while those in the mechanical storage averaged 39.8,—a difference of about one point in favor of mechanical cold-storage. The average of the total scores was 93.5 out of 100 for the lots in ice cold-storage, while the samples in mechanical storage averaged 94.8,—a little over one point in favor of mechanical cold-storage for butter.

Moving Butter from a Moderate to a Low Temperature.

On alternate weeks with the foregoing experiments, two boxes of butter were made, one of which was placed in mechanical cold-storage where the temperature ranged from 38 to 40 degrees, while the other box from the same churning, was put into mechanical storage at once, where the temperature was 28 to 30 degrees F. These lots wers scored at periods of about one week, one month, and three months after being made.

There was little or no difference in the lots at the first time of scoring, about one week after being made. At the second and third scorings, the lots put at once into the refrigerator at the low temperature were better in flavor, though there was little or no difference in other points. The average of all scores in flavor was 41.8 for the lots placed directly in cold-storage at the low temperature. Those which were placed for one week in a refrigerator at an average temperature of 38 to 40 degrees and then removed to a temperature of 28 to 30 degrees, scored an average of 41.2 out of 45, for flavor—or about half a point less than the lots put at once into cold-storage at 28 to 30 degrees. The total average scorings were 96.8 and 96, respectively, for the lots at the low temperature and for those moved from a moderate to a low temperature at the end of one week.

Conclusions. 1. Mechanical cold-storage at the same temperature, according to these experiments, appears to be more favorable for holding butter than an ice-cold storage, probably on account of the drier atmosphere in the mechanically cooled room.

2. Butter placed directly in cold-storage at 28 to 30 degrees F. was better in flavor at the end of one and three months than were similar lots placed for one week in a refrigerator at a temperature of 38 to 40 degrees F., and then moved to a colder room. These experiments indicate the advisability of placing butter as soon as made in a refrigerator where the temperature is as low as possible.

3. While the mechanical cold-storage has given the best results as compared with ice for holding butter, the expense and difficulty of operating these machines, as at present constructed, make their use too expensive for the average creamery.

Cheese Experiments.

The ripening or curing of cheese is such an important question at the present time in relation to our cheese industry, that most of the experimental cheese work of the past year had reference to this phase of cheesemaking. Continuing the policy, which we have followed for several years, we have carried on several lines of work done in former years, and have added some new features in 1903. We think that more accurate information can be obtained by carrying on important experiments for several years, rather than depending upon work done during one season.

The milk for our cheese work is nearly all supplied by patrons who deliver it, as is commonly done at cheese factories throughout the country. The amount required for each experiment is carefully weighed and sampled for fat-content. A test of the acidity is made ; and if the milk is to be divided, the whole lot is mixed in one vat, and the separate quantities required are taken out and carefully weighed. At the same time, we are careful to have the same quality of milk, as far as possible, in each vat. In our regular work, the cheese are made according to Canadian Cheddar principles as taught in the Dairy School, and practised throughout Ontario. Most of the cheese were made into "flats," weighing about thirty pounds each. Some large cheese were made for special experiments. After taking the cheese from the press they were accurately weighed and marked, and placed in the various ripening (or curing) rooms, of which we have eight in our dairy. Six of these were used for the experiments of the past season. Our ordinary ripening rooms were cooled by means of a sub-earth duct. The temperature was fairly uniform at about 60 degrees F. to 65 degrees F., and averaged 61.70 degrees for the season. The percentage of moisture in the air averaged 78 for the season. Two of the other rooms were cooled by the use of ice, and three of them by mechanical refrigeration—the ammonia system.

In from six weeks to two months after being made, the cheese were scored by an expert according to the following scale of points : Flavor, 40 ; closeness, 15 ; even color, 15 ; texture, 20 ; finish, 10 ; total, 100. All cheese were scored full points (10) for finish. We are indebted to Messrs A. T. Bell, I. W. Steinhoff, and G. H. Barr for assistance in scoring these cheese.

After the first scoring, the cheese were usually scored again in about one month's time, and, if necessary, once a month thereafter, until it was considered that there would be no advantage in further scoring. The cheese were then sold.

The various cheese experiments of the year may be conveniently grouped into several series.

Series A 1.—Ripening in an Ordinary Room versus Ice and Mechanical Cold Storage. Cheese moved from Ordinary Room to Ice Cold Storage at End of One Week.

In this series nine lots of cheese were made between May 4th and November 9th. The quantity of milk used for each experiment averaged 1,607 pounds, testing an average of 3.7 per cent. fat. Five cheese, weighing about 30 pounds each, were made from each lot of milk. The cheese marked A were placed, when taken from the hoop, in an ice cold storage, which was at an average temperature of 40 degrees F., and the moisture in the air was 87 per cent. The B cheese were in mechanical storage at 40 degrees F. The C cheese were ripened in a mechanical storage of 50 degrees F. The D cheese were ripened in an ordinary room at 61 degrees F. for one week. These D cheese were then moved into an ice cold storage at 40 degrees F. The E cheese were ripened in the ordinary room.

The aim of the experiments was :

1. To compare an ordinary ripening room with ice and mechanical cold storage for ripening cheese.

2. To compare ice and mechanical cold storage for cheese ripening—both at the same temperature.

3. To compare the effects of two different temperatures—40 and 50 degrees, in mechanical cold storage, where the percentage of moisture in the air was about 76.

4. To note the effects of leaving cheese for one week in an ordinary ripening room before moving them to an ice cold storage.

5. To determine the loss of weight when ripening under the various conditions.

Series A. 2. Cheese moved from ordinary room to mechanical cold storage at end of one week.

As series A 2 is very similar to A 1, we shall consider the results together. The chief difference in these two experiments is that in the second series, the D cheese were moved at the end of one week from the ordinary room to the mechanical cold storage, where the temperature averaged about the same as it did in the ice storage. The chief object was to see whether or not there was any difference in quality when cheese were moved at the end of a week into a mechanical storage from an ordinary room as compared with ripening for the full period in an ordinary room, ice storage, or mechanical cold storage.

Between May 11th and November 16th nine lots of five cheese each were made from an average of 1,590 pounds of milk, testing 3.7 per cent. fat. The cheese were weighed when taken from the hoops, and marked A, B, C, D, and E, as in series A 1. The A cheese were ripened in an ice storage at 40 degrees F., the C's in mechanical storage at 50 degrees F., the D's for one week in an ordinary room and then moved to mechanical storage at 40 degrees F.; the E's in an ordinary room at 61 degrees F., and the B's in mechanical storage at 40 degrees F.

Table Showing Results in Series A 1 and A 2.

Cheese.	Method of Ripening.	Percent loss in weight in 1 month.	Average Score.				
			Max. 40 Flavor.	Max. 15 Closeness.	Max. 15 Even Color.	Max. 20 Texture.	Max. 100 Total.
A (series a 1) ...	Ice storage at 40 degrees F	1.9	37.0	14.2	14.6	18.5	94.4
A (series a 2) ...	Mechanical at 40 degrees F	2.3	37.0	14.1	14.6	18.4	94.2
B (series a 1) ...	Mechanical at 40 degrees F	3.0	37.7	14.1	14.4	18.6	95.0
B (series a 2) ...	Mechanical at 40 degrees F	2.7	37.8	14.5	14.5	18.6	95.6
C (series a 1) ...	Mechanical at 50 degrees F	3.3	36.8	14.1	14.4	18.0	93.5
C (series a 2) ...	Mechanical at 50 degrees F ...	3.2	37.0	14.3	14.3	18.1	93.8
D (series a 1) ...	Moved to ice storage 40° F.	2.9	36 8	13.9	14.4	18.3	93.5
D (series a 2) ...	Moved to mech. storage 40° F.	3.0	37.7	14.4	14.4	18.6	95.3
E (series a 1) ...	Ordinary room 61° F.....	4.0	33.8	13.5	13.8	16.9	88.2
E (series a 2) ...	Ordinary room 61° F.....	3.9	32.9	13.5	13.9	16.7	87.1

Conclusions :

1. As in former years, the cheese ripened in an ice cold storage at 40 degrees F. were superior in quality to those ripened in an ordinary room at an average temperature of 61 degrees F.

2. In the first series, the cheese ripened in mechanical cold storage at 40 degrees F. averaged slightly better than did those in the ice cold storage at the same temperature. The improvement was chiefly in the flavor of the cheese.

3. In both cases the cheese ripened at 40 degrees F. gave better results in quantity than did those ripened at a temperature of 50 degrees F. The improvement was chiefly in flavor and texture of the cheese.

4. The cheese which were allowed to remain in an ordinary ripening room for one week before being moved to an ice cold storage scored slightly lower (.9 points) than those ripened altogether in the ice cold storage. The cheese moved at the end of one week to a mechanical cold storage scored slightly higher (1.3 points) than did those ripened for the full period in the cold storage. We may conclude that there is little or no risk in spoiling the quality by allowing cheese to remain in an ordinary room for one week, so long as the temperature does not go above 70 degrees before moving to cold storage.

The shrinkage during one month in the A series, ripened in an ordinary room, was 4 per cent. In the second series it was 3.9 per cent. The cheese ripened in an ice cold storage lost an average of 1.9 per cent. in one month. Those ripened in mechanical cold storage at 40 degrees F. lost 2.6 per cent., while those ripened at 50 degrees F. lost an average of 3.25 per cent. The cheese moved to ice cold storage at the end of one week lost an average of 2.9 per cent., and those moved to mechanical storage lost 3.0 per cent. The shrinkage was greatest in the ordinary room averaging about 4 per cent. for cheese weighing about 30 pounds each. The loss was least in the ice cold storage, being less than 2 per cent., or about one-half the loss sustained in the ordinary room. The shrinkage was greater in the mechanical cold storage than in the ice storage, and increased with the rise in temperature. The loss was about one-half a per cent. greater at 50 degrees than at 40 degrees. The cheese allowed to remain in the ordinary room for one week lost 1 per cent. more than those ripened for the full period in an ice cold storage, and about one-half a per cent. more than those in the mechanical storage.

Summing up, we may conclude that a temperature of 40 degrees gave best results in ripening cheese in both series. The quality of the cheese was slightly better in the mechanical cold storage, but the shrinkage in weight was greater than for the cheese ripened in the ice storage. The loss in shrinkage is greater from leaving in the ordinary room for one week, but the effect in quality is very little.

Series B.—Moisture in Curd and Cheese.

Between April 28th and August 22nd, the moisture in sixteen lots of cheese was determined at four different stages, viz., dipping, milling, green cheese, and ripe cheese. It was designed that the lots marked A should contain an excessive amount of moisture at all four stages, while the lots marked B were made normal as nearly as possible. The two chief objects of the experiments were to ascertain what amounts of moisture are usually left in curd at different stages, and also the relative amounts of moisture which green and ripe cheese contain. We also wished to see how much extra moisture may be left in curd and cheese without affecting the quality. Some of the lots were ripened in an ice cold storage and some in a mechanical cold storage—both rooms at a temperature of 38 degrees to 40 degrees F.

The average percentage of moisture in the two lots was :

	A.	B.
At dipping	55.195	51.297
At milling	42.423	40.433
Green cheese	36.075	34.154
Ripe cheese	35.656	33.889

The percentage of salt in both lots of green cheese was also determined with a standard silver nitrate solution after washing the cheese repeatedly in warm water. The A lots averaged 2.49, and the B lots 2.40 per cent. of salt.

The cheese of the different experiments were judged from time to time, usually once a month, during the season. The following is a summary :

Method of Ripening.	A cheese containing excessive moisture.			B cheese containing normal moisture.	
	Scoring.	Av. flavor (max. 40.)	Av. totalscore. (max. 100.)	Av. flavor (max. 40.)	Av. total. (max. 100)
In ice cold storage 38°-40°....	1st score	36.7	93.2	37.5	95 5
" "	2nd score. .	34.6	88.5	35.3	91.1
Mech'l cold storage 38°-40°....	1st score...	37 7	94.7	38.2	96.2

Conclusions :

1. Normal curds contain about 50 per cent. moisture at dipping, 40 per cent. at milling, 34 per cent. when taken from the hoops, and when ripened in cold storage at a temperature of 38 degrees to 40 degrees the cheese at the end of one month will have lost very little moisture.

2. An excess of about 2 per cent. moisture in the green and ripe cheese did not materially affect the quality of the cheese. However, the average quality of those lots containing excessive amounts of moisture and ripened in cold storage was slightly poorer than was the quality of those lots containing a normal amount of moisture.

3. By reducing the amount of stirring given to curds after dipping, the moisture content of cheese may be increased one or two per cent., and where the cheese are ripened at a temperature of about 40 dgrees F. in mechanical cold storage, there would appear to be little danger of injuring the quality of the cheese.

4. The A cheese in ice cold storage lost 2.1 per cent. in weight in one month, the B cheese 3.4 per cent. In mechanical storage the A cheese lost 4 per cent., and the B cheese 3.4 per cent. In the ice storage the cheese with the excessive moisture lost less, and in the mechanical storage they lost more, in weight during one month.

Series C.—Effect of Rennet on Cheese Ripened in Cold Storage.

Seven lots of cheese, in which two, three and one-third, and six ounces of rennet per 1,000 pounds of milk, were ripened in a mechanical cold storage at 40 degrees F., between May 29th and September 19th. The cheese marked A were made by using from 2 to 6 ounces of rennet per 1,000 pounds milk. The milk contained an average of 3.7 per cent. fat. The cheese lost 3.1 per cent in weight at the end of one month. They averaged 37.4 points out of a possible 40 for flavor. Their average total score was 95. The B cheese, made from similar milk, but in which three and one-third ounces of rennet per 1,000 pounds milk were used, lost 3.3 per cent. in weight while ripening, and scored the same number of points for flavor. The average total score was 94.7.

Eight lots were made in a similar way, but were ripened in an ice cold storage at 40 degrees F. The A cheese containing from two to six ounces of rennet per 1,000 pounds milk lost 2.2 per cent. in weight during one month, while the B cheese, made with a normal (3 1-3 ounces) amount of rennet, lost 1.8 per cent. in weight. The average scores for flavor were the same in both lots (37.2), and the average total scores were the same, 93.9.

Conclusion :

So far as these experiments have gone, it would not seem to make much difference in the loss of weight while ripening, nor in the quality of the cheese, whether a small amount (2 ounces per 1,000 pounds milk), a normal amount (3 1-3 ounces), or a large amount (6 ounces) of rennet be used in the milk for making cheese to be ripened in an ice or in a mechanical cold storage at about 40 degrees F. As an extra amount of rennet causes the cheese to ripen more quickly, in those cases where cheese are placed in cold storage soon after being made, and where they are needed in a shorter time than usual for market, it would seem to be quite safe to use from four to six ounces of rennet per 1,000 pounds milk without any danger of injuring the quality of the cheese.

Series D.—Effect of Five Different Temperatures on Cheese Ripening.

In this series, which was conducted on six different dates between August 31st and October 5th, thirty-six cheese, weighing about 30 pounds each, were made from 9,643 pounds milk, testing an average of 3.8 per cent. fat. After weighing, the cheese were marked A, B, C, D, and E, five cheese in each lot, and placed in five different rooms at various degrees of temperature and moisture. Two of the rooms were cooled by means of ice, and three of them by means of mechanical refrigeration on the ammonia circulating air plan.

Table Showing Effects of Five Temperatures in Cheesemaking.

Cheese.	Method of ripening.	Av. temp.	Av. per cent moisture in room.	Per cent lost in ripening.	Average quality of the cheese.				
					Flavor. Max. 40	Closeness. Max. 15	Even color. Max. 15	Texture. Max. 20	Total. Max. 100
A	Ice cold storage.....	40° F.	78	2.28	37.0	14.1	14.6	18.2	94
B	Mechanical cold-storage	40° F.	76	2.34	37.2	14.2	14.2	18.2	94
C	Mechanical cold-storage	50° F.	76	2.90	37.1	14.1	14.4	18.2	93.8
D	Mechanical cold-storage	29° F.	80	1.80	37.1	14.2	14.2	18.1	93.7
E	Ice cold-storage	53° F.	83	3.60	37.1	14.1	14.5	18.2	93.7

Conclusions :

In a range of temperatures from 29 degrees F. to 53 degrees F., the best results were got from ripening cheese at a temperature of 40 degrees F. In all our experimental work on this question, we have had the best results from ripening cheese at this temperature. There would seem to be no advantage in ripening at a lower temperature, although there were apparently no bad results from ripening the cheese at a temperature as low as 29 degrees F., or three degrees below freezing point. The surprising thing regarding the cheese ripened at this low temperature was the fact that after the first month or six weeks they appeared to "break down" as freely as did those ripened at a higher temperature. After an initial stage, the ripening process appears to take place at about the same rate, regardless of temperature, at least between 29 degrees F. and 53 degrees F.

Whether or not it will pay to ripen cheese at 40 degrees F., as compared with 50 to 60 degrees, is a question which has not yet been settled ; but if we are aiming at the best quality of cheese, a temperature of about 40 degrees F. would seem to be the ideal temperature. The shrinkage is also considerably less at 40 degrees than at 50 to 60 degrees.

Series E.—Moving Cheese from Cold Storage to Ordinary Temperature at end of One, Two and Three Months.

This experiment is a continuation of the work done in 1902, to see the effect of moving cheese from cold storage into a room where the temperature ranged from 60 to 70 degrees F. The cheese were made from April 13th to August 17th—eight lots of five cheese in each. The weight of milk used was 12,557 pounds—an average of 1,572 pounds for each experiment. The fat in the milk averaged 3.7 per cent.

The cheese marked A were ripened during the whole period in an ice cold storage. The B cheese were moved to an ordinary room from the ice storage at the end of one month. The C cheese were moved at the end of two months, the D cheese at the end of three months, while the cheese marked E remained in the ordinary room during all the period of ripening. All the cheese averaged about thirty pounds in weight.

The cheese were weighed when green, and again at the end of one month. Two lots, those of April 13th and August 17th, were weighed a third time at the end of four months, while the lot of July 20th was weighed a third time at the end of five months. The object was to see what loss in weight would occur under these conditions at a time when the cheese would be likely to pass into the hands of retailers.

Cheese.	Method of ripening.	Av. per cent. lost in weight.		Average quality of cheese.				
		1 mo.	4 and 5 mos.	Flavor. Max. 40	Closeness. Max. 15	Even color. Max. 15	Texture. Max. 20	Total. Max. 100.
A	Ice cold-storage at 40 degrees...	1.64	5.1	36.8	14.1	14.4	18.4	93.8
B	Ice cold-storage, 1 month.....	1.47	7.3	34.1	13.5	14.5	17.1	89.3
C	Ice cold-storage, 2 months.....	1.60	6.9	34.4	13.7	14.7	17.1	89.9
D	Ice cold-storage, 3 months.....	1.60	6.6	35.8	14.0	14.7	18.4	92.9
E	Ordinary room	3.89	7.8	33.0	13.7	14.3	17.0	88.1

Conclusions :

1. The cheese ripened in an ice cold storage at 40 degrees F. are again first in quality.

2. The longer the cheese remained in the cold storage before moving to the ordinary room the better was the quality of the cheese. The improvement was chiefly in the flavor and texture of the cheese.

3. The cheese ripened for the full period in the ordinary room were poorest in quality, as in all the other series.

4. There was no marked deterioration in quality, after moving from the cold storage to the ordinary temperature, especially in those which were left in the cold storage for three months before moving them. A retailer need not expect any rapid deterioration in the quality of the cheese which has been kept for two or three months in cold storage, providing the cheese were of good quality when made.

5. Cheese continue to lose in weight after the first month, whether kept in cold storage or not, but the loss was greater on those cheese moved to the warmer room. This loss can doubtless be prevented to a large extent by coating the cheese with paraffin wax.

Series F.—Placing Cheese on Shelves versus Boxing Directly from the Press.

Between May 2nd and June 27th, eight experiments were made, in which 11,197 pounds milk testing an average of 3.6 per cent. fat, were made into sixteen cheese. Two cheese weighing about 70 pounds each were marked A and B. The A cheese were placed on

shelves in an ice cold storage at an average temperature of about 40 degrees F. and 87 per cent. moisture in the air. The B cheese were put directly into cheese boxes, and were also placed in the same ice cold storage, without turning them in the box or turning the boxes.

The cheese placed on the shelves lost 1.7 per cent. in weight during one month, while those put in the boxes lost 1.06 per cent. The two cheese made on June 18th were weighed a third time on December 17th (six months later), and the cheese on the shelf had lost 4.8 per cent., while the B cheese in the box had lost 4.0 per cent. The average score for flavor was 36.8 and 37, respectively, and the average total scores were 92.5 and 92.6. There was little or no difference in the quality of the cheese.

Three experiments were made by placing one cheese on a shelf in a mechanical cold storage at 40 degrees F., while a similar cheese from the same vat of milk was put directly into a box in the same storage, without turning the cheese or the box. The cheese on the shelf lost 2.7 per cent. in weight during one month, while those in the boxes lost 2.5 per cent. in the same time. These lots, which were made July 2nd, July 3rd, and October 12th, were weighed on December 17th, when the cheese on the shelf had lost 5 per cent., and those in the boxes 4 per cent. in weight.

The average scoring for flavor was 36.8 and 37.2 respectively, for the cheese on the shelves and in the boxes. The total scores were 94.8 and 95.4, a slight advantage in favor of the cheese in boxes.

Eight experiments were made from June 9th to the 26th, by placing cheese on the shelf in an ordinary ripening room, while similar cheese from the same vats of milk were put directly into boxes in the same room without turning.

The cheese on the shelf lost 3.2 per cent. in weight during one month, while those placed directly in boxes from the hoops lost an average of 2.4 per cent. The average scores were 90.8 and 90.9, practically the same. The chief disadvantages of placing cheese directly in the box in an ordinary room are the large amount of mould on the cheese, and the "huffing" of the cheese, where they are not turned. By turning the boxes frequently this latter difficulty could be overcome.

Conclusions :

1. Cheese may be placed directly from the press in clean, dry boxes, if kept in either ice or mechanical cold storage, without any danger of injuring the quality of the cheese. The only drawback is the mould on the cheese, especially in an ice storage.

The boxing of cheese when green and leaving them in an ordinary ripening room is not to be recommended, owing to the "huffing" of the cheese and the large amount of mould which collects. Spraying with formalin tends to check the latter, while turning the boxes tends to prevent the "huffing."

2. The cheese put directly into boxes lost considerably less in weight than did those on the shelves, hence the plan of boxing is an advantage in this respect, as it saves shrinkage.

3. In this series, as in several of the others, the loss in weight during one month was greater in the mechanical storage, but the quality of the cheese was slightly better than were those in the ice cold storage. Both lots were better in quality, and the shrinkage was less than in those ripened in the ordinary room.

Series G.—Temperatures for Cooking Curds

In this series, which was conducted between July 22nd and October 20th, 3,900 pounds milk, testing an average of 3.7 per cent. fat, were made into thirteen cheese and marked A. A similar lot made from similar milk were marked B, making 26 lots of cheese altogether in the experiment. The A cheese were cooked at an average temperature of 104.4 degrees. The temperature ranged from 102 to 110 degrees. The B cheese were cooked at an average temperature of 99.7, and ranged from 98 to 100

degrees, the usual range of temperature adopted at this stage of Canadian Cheddar cheesemaking.

The average acidity of the two lots at three stages of the making was:

	A. Per cent. acid.	B. Per cent. acid.
Dipping	.186	.190
Milling	.843	.952
Salting	.996	1.155

It will be noticed that the curds cooked at the higher temperature had slightly less acid at all three stages of the process.

The yield of green cheese from 3,900 pounds milk cooked at the higher temperatures was 390.44 pounds, and of ripened cheese 375.44. The normal lots weighed 396.13 pounds when green and 379.5 pounds of ripened cheese. The decreased yield of cheese on 3,900 pounds milk from cooking at the higher temperature was 5.60 pounds green cheese and 4.0 pounds of ripe cheese, or cheese one month old. The A cheese lost 3.7 per cent. in weight during one month, while the B, or normal cheese, lost 4.1 per cent. in shrinkage. The cheese of both lots averaged about 30 pounds each in weight.

The average scores were :

	A.	B.
Flavor	35.8	35.3
Closeness	13.8	13.7
Even color	14.0	13.5
Texture	17.4	16.7
Finish	10.0	10.0
Total	91.0	89.2

Conclusions :

1. Heating the curds to temperatures of 102 degrees to 110 degrees tended to reduce the percentage of acid in the curds at all the important stages of the process of cheesemaking. In the case of curds which tend to "work too fast," it would seem advisable to heat them to a higher temperature than usual in order to check the development of lactic acid. It is possible that normal curds may be advantageously heated to a higher temperature than is now considered necessary.

2. Heating curds to the higher temperatures appears to reduce the yield of cheese obtained from milk. In our experiments the loss was about 4 pounds of ripe cheese on 3,900 pounds milk testing 3.7 per cent. fat.

3. The average quality of the cheese was improved by cooking the curds at the higher temperature.

Further data is necessary on these points before we can speak positively as to the merits of adopting a higher cooking temperature than is now considered advisable by the best Canadian cheesemakers.

DAIRY STOCK.

Cocoa-shell Milk for Calves.

In cheese factory districts farmers find difficulty in obtaining sufficient milk to feed the calves. Various substitutes have been tried, but none of them has proved entirely satisfactory. The by-product in the manufacture of cocoa, known as cocoa-shells (not

cocoanut shells), have been used by some dairymen as a substitute or partial substitute for milk. To test the value of this food for calves, we purchased 200 pounds of the shells in Toronto at a cost of three cents per pound. The freight to Guelph was 91 cents, making a total cost of $6.91 for 200 pounds of the cocoa-shells delivered in Guelph.

The experiment began July 21st and ended September 15th, 1903. Four calves—two pure-bred Ayrshires and two Holstein grades—were used for the test. The Ayrshires were about five months old, and the grade Holsteins about one month old when the experiment began. One Ayrshire and one Holstein were placed in each group. Group 1 was fed on skim-milk, bran, oats, hay, pasture, and some green feed. One calf of group 2 was fed on cocoa-shell milk, meals, pasture, etc., the same as group 1, while the second calf received half skim-milk, and half cocoa-shell milk, meal, etc.

Each calf was weighed on two consecutive days at the beginning and close of each period, which lasted four weeks. At the end of four weeks the groups were reversed.

The cocoa-shell milk was made by boiling one-quarter of a pound of cocoa-shells in two gallons of water. The calves were given from 14 to 20 pounds (1 1-2 to 2 gallons) of the cocoa milk per day. The calves fed on skim-milk and cocoa-shell milk were given equal quantities of each. They seemed very fond of the cocoa-shell milk.

The two calves fed on skim-milk (1 1-2 gallons to 2 gallons per day), meal, etc., gained 148 pounds in eight weeks. The total gain of the two calves fed on the cocoa-shell milk, meal, etc., in eight weeks was 135 pounds. The difference in gain was 13 pounds on two calves in eight weeks in favor of the skim-milk.

Taking the calves singly, we find that one of the Ayrshire calves gained 48 pounds in four weeks on skim-milk, meal, etc., while on the cocoa-shell milk it gained 31 pounds. The other Ayrshire gained 30 pounds on the skim-milk and 42 pounds on the cocoa-shell milk. One of the grade Holsteins gained 45 pounds on the skim-milk and 20 pounds on the milk and cocoa in four weeks, while the other gained 25 pounds on the skim-milk and 42 pounds on the skim-milk and cocoa. This difference in gain appears to have been influenced by the weather, as all the calves made much larger gains in the first period, during the latter part of July and the beginning of August, than during the second period, in the latter part of August and the first part of September.

The total gain of the two Ayrshires on skim-milk was 78 pounds, while on the cocoa-shell milk their gain was 73 pounds. The grade Holsteins gained 70 pounds on the skim-milk, and 62 pounds on skim-milk and cocoa.

Conclusion :

Cocoa-shell milk made by the boiling of about one-quarter of a pound of cocoa-shells in water and feeding from one and a half to two gallons per day along with bran and oats, green feed, etc., appears to be a very good substitute for skim-milk, and is worthy of a trial by those farmers who wish to rear calves and have little or no skim-milk to feed. However, there is probably no substitute which will entirely take the place of milk for young stock.

Sugar Beet Pulp for Dairy Cows.

In the latter part of January, 1903, a carload of sugar beet pulp was sent to the Dairy Department of the College from the beet sugar factory at Berlin. The object of the experiment was to see whether or not the beet pulp would satisfactorily take the place of mangels in a ration for dairy cows. Our regular ration contained corn silage, clover hay, mangels, bran, oats, and oil-cake. For the first ten days of February fifteen cows were given their regular ration, the milk being weighed, as usual, at each milking, and

composite samples were taken for testing. At the end of ten days each cow's composite sample was tested for fat. During the ten days the fifteen cows gave 3,787 pounds milk, containing 130.116 pounds fat. The average percentage of fat from all the cows was 3.43. During the next ten days these cows gave 3,600 pounds milk, which contained 128.062 pounds fat, while being fed beet pulp instead of mangels in their ration. About 20 pounds (1-3 bushel) of the mangels and pulp were fed to each cow in a day.

During the last day or two of the beet pulp period we were obliged to feed timothy instead of clover hay.

The cows gave 187 pounds less milk on the beet pulp, but there was a difference of but little over two pounds fat on the fifteen cows in ten days, owing to a higher average test. It is not likely that the beet pulp caused this difference.

It is interesting to note that when the cows were changed from mangels to beet pulp the milk of eight cows increased in the percentage of fat, four cows gave milk with a lower percentage of fat, and three gave milk with the same fat content in both periods. Two cows increased in the quantity of milk they gave, and thirteen decreased when beet pulp was substituted for the mangels.

During the month of March we continued feeding the pulp in our regular ration instead of mangels to our whole herd. In the month of April they received mangels again, as the pulp was all fed by the end of March. Eleven of our cows were milking during both months. In March, when fed the sugar beet pulp, they gave 9,196 pounds milk, which contained 326.775 pounds fat. The average percentage of fat was 3.57. During April, when fed mangels, these eleven cows gave 7,775 pounds milk, containing 279.636 pounds fat. The average percentage of fat in the milk for April was 3.59.

In April, when fed mangels, the cows gave less milk and fat than they did in March, when receiving sugar beet pulp. This difference, to some extent at least, was due to advancing lactation in a number of the cows.

Conclusions :

1. Sugar beet pulp produced less milk than mangels in one period and more milk in another period.

2. The cows were fond of the pulp, and ate it as readily as the mangels.

3. When fed along with corn silage, not more than 20 to 30 pounds (about 1-3 to 1-2 bushel) per day should be fed to a cow, as it tends to "scour" them if fed in large quantities in addition to silage. If fed with dry feed, such as cut hay or straw or corn stover, it may be fed quite safely in larger quantities. It is also likely to be more valuable in a dry ration than in one which already contains considerable succulent material, such as silage.

4. In those districts where the beet pulp can be got fresh from the factory, or if it be stored in a silo, it may well be used as a substitute for roots in the ration for cows giving milk.

5. We did not observe any taint or unpleasant odor on the milk while feeding the beet pulp.

Dairy Herd.

The herd at the Dairy Department on December 31st, 1903 consisted of : 11 Holstein cows, 2 heifers, 3 heifer calves, 1 yearling bull and 1 bull calf, 3 Jersey cows and 3 heifers, 4 Ayrshire cows, 2 heifers and 2 calves, making a total of 50, but several of these will be sold shortly to the butcher, as they have proven to be unprofitable.

The record of the herd for the year is shown in the following table :

Record of Dairy Herd from Jan. 1st, 1903, to Dec. 31st, 1903.

Name or No. of cow.	Breed.	Live weight.	No. days milking.	Lbs. milk.	Per cent. fat in milk.			Lbs. fat in milk.	Lbs. butter, adding one-sixth to the fat.	Value of fat at 20c and 25c. per lb.	Value of the milk at 4c. a quart.
					Average.	Highest monthly.	Lowest monthly				
1 Molly, 21	Gr. Holstein	1,320	320	10,214	3.5	3.8	3.1	358.27	417.98	76 18	163 42
2 Daisy of R., 41	Holstein	1,010	310	9,450	3.2	3.6	2.8	298.49	348 23	66 77	151 20
3 Beauty of N., 67	"	1,080	312	9,352	3.6	4.8	3.2	330.05	385.05	73 29	149 63
4 Marg. C., 15	"	1,400	294	8,824	3.1	3 6	3.0	279.56	326.15	61 74	141 18
5 Dolly, 17	Gr. Holstein	1,455	309	8,776	3 6	4.2	3.2	303.61	354.21	67 15	140 42
6 Marcena, 38	Holstein	1,025	238	8,162	3.5	4.3	3.0	285.65	333.25	59 00	130 59
7 20	Grade	1,160	289	7,383	3.7	4.0	3.4	282.33	329.38	63 09	118 13
8 Lucy, 2	Gr. Holstein	1,090	294	7,352	3.3	3.6	3.0	243.92	284.57	50 48	117 63
9 74	Gr. Holstein	905	243	6,843	3.2	3.5	2.9	217.31	244.47	44 42	109 49
10 Polly, 1	Gr. Holstein	1,160	274	6,807	3.5	3.8	3.2	228 74	266 86	48 13	108 91
11 Mary W., 32	Holstein	1,363	325	6,714	3.3	3.8	3.0	223.75	261.04	49 61	107 42
12 Pan-a-Meg., 85	Holstein	965	325	6,108	3.2	3.5	3.0	198.72	231.84	42 31	97 73
13 53	Gr. Holstein	1,030	263	5,507	4.3	5.1	3.6	220 99	257.82	45 42	88 11
14 76	Holstein	995	259	5,228	3.2	3.6	3.0	169.35	197.67	34 49	83 64
15 Jean, 28	Gr. Ayrshire	1,080	269	5,213	3.9	4.6	3.0	198.84	231.98	41 16	83 41
16 Lily., 26	Jersey	830	309	4,825	4.8	5.2	4.4	227.07	264.91	49 57	77 20
17 Bella, 44	Gr. Ayrshire	1,020	358	4,736	3.7	4.1	3.5	176.53	205.95	38 56	75 78
18 Patti, 30	Ayrshire	930	257	4,735	3.8	4.4	3 6	180.14	210.16	38 56	75 76
19 Glen Bessie, 65	Ayrshire	975	293	4,233	3 8	4.2	3.6	160 98	187.81	33 76	67 73
20 Emerald R., 55	Jersey	950	207	3,775	4.4	4.6	4.2	167.69	188.65	36 87	60 40

Comments on Herd Record.

1. The largest yield of milk (10,214 pounds) and butter (418 pounds) was by a grade Holstein cow of our own breeding. The second, third and fourth largest yields are by pure-bred Holsteins. The cow which stood first during the past two years is sixth on the list this year.

2. Six cows gave yields of over 8,000 pounds milk and over 325 pounds butter during the year. Twelve cows gave over 6,000 pounds milk each. The average for the herd was but 6,711 pounds milk and 276 pounds butter, which was disappointing. It is evident that a number of these cows will have to be sold, as they do not come up to our standard of requirement. Several of them are pure-bred cows. Some, however, are heifers with first and second calves. A few of them will be given another opportunity to see if they can improve their record.

3. The value of the milk fat per cow at the prices which we pay for milk, viz., 25 cents per pound fat for four months of the year (December to March), and 20 cents per pound fat for eight months, ranged from $76.18 to $33.76, and averaged $51.02. The value of the milk at four cents per quart, the price at which we sell milk, ranged from $163.43 to $60.40 per cow, averaging $107.38.

The Farm Department has supplied the dairy cows during the year with pasture, hay, silage, roots, and bedding.

All of which is respectfully submitted,

H. H. DEAN,

Professor of Dairy Husbandry.

PART IX.

THE PROFESSOR OF AGRICULTURE AND FARM SUPERINTENDENT.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to submit herewith my eleventh annual report.

The nature and scope of the work in animal husbandry and agronomy is indicated by the College circular, and requires no extended notice here. Prof. Cumming has shared the work with me, and the ground has been covered as fully as the time allotted to these subjects permits, though more time could be used to advantage in some branches.

The special two weeks' course in stock judging proved very popular again this year, and some new features were introduced, notably the slaughter test in the case of fat steers, which were first judged alive by the class. In March a second two weeks' course in stock judging was conducted for the benefit of farmers' institute workers, and those who acts as judges on the fall fair circuits.

Unfortunately, the object of the short course has been misunderstood by many people who should know better. It has been stated that we took in all applicants, and pretended to turn them out expert judges after a two weeks' course of training. Nothing, of course, could be wider of the mark; and perhaps it may not be out of place to state the two main objects of the short course, so far as live stock is concerned. They are as follows : 1st. To give those who have had little or no experience in judging a foundation upon which to build in the future. 2nd. To enable those who are already more or less proficient in judging to compare notes with other equally good or better judges, and thus tend to bring about more uniformity in methods of judging, and promote harmony of views as to what constitute desirable and undesirable types.

Farm Superintendence.

This department of my work requires a large share of my time, and sometimes scarcely receives the attention which it should, owing to the demands made by other work. Following are notes on the principal crops grown during the past year :

Meadow. We had 85 acres of hay, which yielded about two tons per acre. Most of the hay was harvested in very good condition, though some was damaged by rain. This in the second year we have used the side delivery rake and hay loader, and we are well satisfied with the method.

Our method of treating the hay varies with the weather and the kind and weight of the crops. Heavy, sappy clover is usually cut in the morning, tedded during the afternoon, raked with the side delivery rake during the next forenoon after the dew is off, and drawn in during the afternoon. Later in the season, when the clover is not so sappy, or in the case of a comparatively light crop, the tedder is not used, the side delivery rake answering the purpose. In the case of timothy, we frequently draw what is cut in the morning during the afternoon of the same day. This is done, however, only under the most favorable conditions for rapid drying. We aim to use the tedder as little as possible, though its use is often necessary in the early part of haying, or when a heavy rain has fallen upon the hay as it lies in the swath. The side delivery rake turns the swaths practically upside down, and leaves the hay in light, loose windrows, which dry out rapidly. We think, also, that the rake does not break so many leaves off the hay as does the tedder, and, therefore, we try to make the rake take the place of the tedder as far as possible. I may add that I would not care to use a hayloader without the side delivery rake.

As to our method of making hay, I am aware that there are many who believe that the only way to make good hay is first to put it up in cocks. While I am ready to admit that the method of cocking hay may give a somewhat better quality than the one we practice, at the same time we can make good hay by our method, and we believe that the immense saving in labor effected thereby far more than compensates for any slight superiority in quality obtained through the older method.

Barley. Twenty acres Mandscheuri variety. Sown April 11th at the rate of 1 1-2 bushels per acre. Commenced cutting July 24th. The crop is not all threshed at the time of writing, but it will yield about 50 bushels per acre.

Cultivation for Barley. Fifteen acres had been under roots and five acres under corn the previous year. The root ground was ribbed up with the double mouldboard plow the previous fall. The corn ground was gang-plowed lightly in the fall, harrowed, and ribbed up. In the spring the ribs were harrowed, then cultivated with the spring tooth cultivator, harrowed again, sown with the drill, and finally gone over with a Breed weeder. The field was rolled after the barley was up. The barley was seeded with red clover and timothy, at the rate of about 8 1-2 pounds red clover and 3 1-2 pounds timothy per acre.

Oats. About 96 acres of the Siberian variety. Sowing commenced April 18th, and cutting August 10th. Sown at the rate of 1 1-2 bushels per acre. The oats were seeded with timothy and clover, as described under barley, except about thirty acres which were sown on fall plowed sod in another section. The growth of straw this year was enormous; and as the crop lodged badly, cutting was rendered very tedious, and this, combined with wet weather, made the completion of the harvest later than it has been for twelve years. Though not all threshed, the yield may be safely estimated at 65 to 70 bushels per acre. Had the crop stood up better, the yield would have been much greater.

Cultivation for Oats. Our oats this year followed potatoes, corn, grass peas, oats, and sod. Sowing oats after oats does not look like a good rotation; but we have been compelled to do this after dropping peas out of the rotation on account of the weevil. Our land, however, is rich enough to grow two crops of oats without injury, and the heaviest straw we had was on the part where the oats followed oats. The potato and corn ground was treated the same as the root and corn ground for barley. The pea and oat stubble was fall-plowed, and in the spring worked down with harrow and spring tooth cultivator into a fine seed bed. The sod was plowed about four inches deep early in September, rolled, harrowed, and subsequently cultivated, so that the sod was fairly well rotted in the fall. The spring cultivation was practically the same as for barley. We have no trouble with the wire worm nor white grub, which is probably due to the fact that our sod is not allowed to stand more than two years.

Winter Wheat. Seven and one-half acres of Dawson's Golden Chaff. It was sown September 6th at the rate of 1 1-2 bushels per acre, and was cut July 22nd. The yield was about 35 bushels per acre. Between 3 and 4 pounds of timothy seed per acre were sown with the wheat, and 8 pounds per acre of red clover seed were sown in March before the frost was out of the ground.

Cultivation for Wheat. Winter wheat followed grass peas, which are rather late in maturing to precede wheat, as not enough time is allowed to get the ground in the best condition for sowing. The land was plowed lightly as soon as the peas were removed, and subsequently worked down with the harrow and cultivator into as fine tilth as possible.

Mangels. Ten acres of Giant Yellow Intermediate. Sown May 9th, in rows thirty inches apart, at the rate of four pounds of seed per acre. Germination was rather unsatisfactory, owing to the dry weather which prevailed during May. The yield was about 600 bushels per acre.

Cultivation for Mangels. Mangels followed sod, which was plowed about four inches deep during the latter part of August and the beginning of September. The ground

was rolled and harrowed after plowing, and later was thoroughly cultivated with the spring tooth cultivator. Manure was applied during the winter at the rate of about 15 tons per acre. In the spring the ground was gang-plowed, harrowed, rolled, gone over with the grubber both ways to thoroughly loosen the lower soil, harrowed, rolled again, and ribbed with the double mouldboard plow for sowing. After sowing the roller was passed over the drills.

Potatoes. Eight acres Empire State. Planting commenced May 13th. Seed potatoes were cut with, at least, two strong buds on each piece, and dusted with land plaster. The crop was sprayed twice with Paris green and Bordeaux mixture. Some early blight appeared in August, but there was very little rot. The yield was a little over 235 bushels per acre, which is a very satisfactory average for an eight-acre plot.

Cultivation for Potatoes. Potatoes followed sod, and fall cultivation was the same as for mangels, except that manure was applied in the fall, and the ground ribbed up with double-mouldboard plows. In the spring, the ground was harrowed down, gang-plowed, grubbed both ways, harrowed, and rolled. Then the double-mouldboard plow was used to open up furrows 30 inches apart, and the potatoes were planted 12 inches apart in the rows. The drills were then split, covering the potatoes. We find that it is important to plant the potatoes immediately after the furrow is opened up, and to cover as soon as possible after planting. After the ground had settled, it was harrowed at intervals until after the potatoes were well above ground. The harrowing checked weeds, and prevented the formation of a crust. It also levelled the ridges. Subsequent tillage was with the horse-hoe, or scuffler. When the plants had attained their growth, a little earth was thrown around them by means of mouldboards attached to the scuffler. This was done to prevent exposure of the tubers to the sun.

Corn. Thirty acres Wisconsin Earliest White Dent. Planted in hills 42 inches apart. Planting commenced May 18th. The cold season affected the crop unfavorably, and the yield would not be more than 12 tons per acre.

Live Stock.

Cattle. Our stock of cattle in the Farm Department comprise the following:

Shorthorn.—1 bull, 6 cows, 1 two-year-old heifer, 2 yearling heifers, and 3 calves.

Hereford.—1 bull, 3 cows, 1 yearling heifer, and 2 calves.

Aberdeen-Angus.—1 bull, 2 cows, 2 two-year-old heifers, 1 yearling heifer, 1 calf.

Galloway.—2 cows, 1 yearling heifer, and 1 calf.

Ayrshire.—1 bull.

Jersey.—1 bull.

Sheep.—Small flocks of Leicesters, Oxfords, and Shropshires are maintained.

Swine.—We have a very good herd of Yorkshires, keeping, as a rule, from eight to ten breeding sows. We also keep three or four Tamworth sows, and about the same of Berkshires. We have been led to increase the number of Yorkshires by the greater inquiry for this breed.

It is my wish to improve the quality of the stock kept upon the College farm. Something has been accomplished along this line during the past year, but much remains to be done, and I am asking for a considerable increase in the appropriation for the purchase of stock.

Notes on Feeding Stock.

Our methods of feeding vary somewhat according to circumstances. As a rule, our bulky food for steers, cows, and young stock, except calves, consists of silage, pulped roots, and cut hay, mixed a day in advance of feeding. This winter, however, we are using oat straw instead of hay, straw being plentiful, and hay somewhat scarce. Calves are fed clover hay and roots, with a very small allowance of silage to the older ones. The bulls get hay and roots, also, but, as a rule, are fed no silage. Our standard

meal ration for breeding stock is oats and bran, the quantity being regulated to meet what we consider the requirements of the case. Calves receive in addition, a small allowance of oil cake. Steers are fed almost any available meal mixture. When we can buy corn at a reasonable price, we use it quite largely. When corn is not available, we use oats and barley, or oats, barley, and wheat. Steers which are to be kept until May or June, get practically no meal before the middle of December, and are then started on 4 or 5 pounds each per day. The quantity is gradually increased, and for the whole feeding period, the average amount of meal is about half a pound per day for every 100 pounds live weight of the steers. Short keep steers, or those intended for February or March shipment, are fed more heavily, commencing with about half a pound of meal per day for 100 pounds of their live weight, and gradually increasing, though we rarely exceed a pound of meal per day for 100 pounds live weight of the steers.

In winter, the sheep subsist mainly upon mixed clover and timothy hay and roots, about 4 pounds of roots being allowed for each ewe. Lambs are fed oats and bran, and usually a little oil cake, and the ewes are also generally fed a small allowance of oats and bran for a month before lambing.

For feeding and management of swine, see bulletin on "Bacon Production" prepared by this department. (Apply to Department of Agriculture, Toronto).

Live Stock Experiments.

Our work with steers consisted of a comparison of the relative economy of feeding long keep and short keep steers; of cutting hay and pulping roots for steers as compared with feeding long hay and whole roots; and also of feeding blood meal along with corn meal in order to give a narrower nutritive ratio.

The experiment with long keep and short keep steers is somewhat similar to our previous work with light and heavy meal rations for fattening steers, but, instead of selecting steers of the same quality, we selected the heavier and fleshier steers for the short keep group, and aimed to force them along so as to be ready for market not later than March, whereas the lighter and thinner steers were selected for the long keep group, and fed with the object of marketing in May, or thereabout. This is the second experiment of this series, and we regard the problem under consideration as a very important one, and intend to continue our experiments until we feel we have obtained reliable information.

In swine, we are continuing our work in connection with the influence of different foods and methods of management upon the quality of bacon. A full account of the last year's work with cattle and swine will be found in the report of the Lecturer in Agriculture.

Outside Work.

As usual, I have received during the past year quite a large number of requests to attend meetings of Farmers' Institutes, and similar conventions. So far as possible, these requests have been complied with, though a number have had to be refused on account of the College work. I am of opinion, however, that it would be better for the College, and for my own department especially, were it possible for me to meet with the farmers of the country oftener than present arrangements permit. The business of the Farm Department, the general oversight and planning of live stock experiments, and various other matters, make it difficult to give that attention to lectures which they should receive, and I believe the time has come when a readjustment of the work of the department would be in the best interests of the institution.

I have the honor to be

Your obedient servant,

G. E. DAY,

Professor of Agriculture.

PART X.

THE LECTURER IN AGRICULTURE.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to submit herewith a brief report of my second years' work as Lecturer in Agriculture.

Teaching.

In the report of the Professor of Agriculture reference is made to the nature and scope of my work as Lecturer in Agriculture, and little further need be added here, unless it is to call your attention to one particularly promising line of work which is carried on, for the most part under my direction, with the senior students. For the greater part of the fall term, and a considerable part of the winter term, it is a very pleasant part of my work to take the senior students, some two or three times a week, to the farms of the leading live stock men within convenient access of the College, and there, with the assistance of some of the breeders, give them practical instruction in the care, management, and judging of all classes of live stock. I have found these live stock men, without exception, most courteous and ready to give our students every opportunity to observe and learn what they can of their methods. I take this opportunity of expressing our high appreciation of the readiness with which these farmers have given their time and assistance to this very important line of work.

Teaching occupies the major part of my time ; but, in addition, I have as far as possible complied with requests to meet with the farmers of Ontario, especially at the exhibitions and fairs, at fifteen of which I have acted as judge during the past fall.

I have also endeavored to assist the Professor of Agriculture, whenever possible, but especially in keeping an oversight of the experimental feeding work, of which a report is given below.

Experiments with Swine.

Owing to the very unfortunate outbreak of contagious pneumonia, to which reference was made in the last year's report, it was deemed inadvisable to conduct any winter experiments with hogs. As a result, the number of experiments conducted with hogs was somewhat limited. They are given below :

Blood Meal and Tankage as compared with Skim-Milk for Hogs.

During the past year, several articles have appeared in the agricultural press deploring the fact that almost all the blood meal and tankage from Canadian packing houses is sold to firms in the United States to be used as commercial fertilizers. It has been pointed out that, in this way, our farms are being drained of a large amount of fertility which ought to be conserved. Most of the writers of the articles, that have, so far, appeared, recommend that these by-products be bought by Canadian farmers and applied by them to the land. The experiment described below indicates that these by-products, when properly prepared, can be still more advantageously used by being fed on the farm and thus a profit be made not only from the feed, but also from the manure of the animals fed.

For the purpose of the experiment, we were supplied with blood meal by the Wm. Davies Company, Toronto, and with blood meal and tankage by Swift & Company, Chicago. The blood meal and tankage from the latter firm is specially prepared for

animal food purposes, and is very much finer in texture and freer from foreign matter than the ordinary commercial by-products of the slaughter house used for fertilizing purposes, such as were supplied by the Toronto firm. The Swift people have a special plant for refining these by-products, and, although this adds considerably to the price of the blood meal and tankage, yet our experiments indicate that the refining process is absolutely necessary. The ordinary commercial blood meal proved unpalatable, and it was found impracticable to continue the experiment with it. Should there, however, arise a demand for these by-products in Canada, we feel sure that our Canadian firms would supply the refined product.

Blood meal, as the term indicates, is dried blood, reduced to meal. The guaranteed analysis of that supplied by Swift is 87 per cent. protein, 3 per cent. ash, 10 per cent. moisture.

Tankage is a prepared product from refuse meat, entrails, and other offal that accumulates in the slaughter house. The guaranteed analysis of that supplied by Swift is 60 per cent. protein, 6 per cent. ash, 10 per cent. moisture.

In this experiment, there were seven groups of pigs—five in each group. The pigs in five of the groups averaged in weight about 33 pounds each. Those in the remaining two groups averaged about 21 pounds each. The bulk of the ration fed to all the hogs was the same, consisting at first of pure middlings, but with a gradually increasing amount of barley, until at last barley was the sole grain food.

The following table shows the ration fed each group :

Group 1.—Meal and blood meal.
Group 2.—Meal and tankage.
Group 3.—(Light weight) Meal and tankage.
Group 4.—Meal and skim-milk.
Group 5.—(Light weight) Meal and skim-milk.
Group 6.—Meal, blood meal, and skim-milk.
Group 7.—Meal, tankage, and skim-milk.

It had been planned to have a light weight group also fed on meal and blood meal ; but the pigs selected for this group were, unavoidably, runts, and, proving inferior feeders, had to be left out of the experiment.

For the first four weeks, the pigs were fed blood meal or tankage in the proportion of 1 to 6—each pig receiving exactly 3-10 of a pound of blood meal or tankage per day. Owing to the limited amount available for the experiment, we were not able to increase the weight of blood meal or tankage ; so the average proportion throughout the experiment was about 1 to 13 of meal.

The light weight pigs were fed about three-fourths as much of these by-products as the others, averaging one-fifth of a pound per day each, and a proportion throughout the experiment of about 1 to 18.

Those pigs getting milk were fed in the proportion of about 2 of milk to 1 of meal throughout the whole experiment, getting at first about 2 pounds of milk each per day and at the last about 10 pounds of milk each per day.

The remaining two groups, which received part milk and part of either blood meal or tankage, received half as much of the by-products as the light weight hogs, and in addition 1 1-4 pounds of milk each per day throughout the experiment.

The blood meal, or tankage, or milk, was mixed with the middlings and barley and the pigs were fed as much as they would eat up clean twice a day. In addition, they were fed at noon a large-sized handful per pen of grass, or clover, or green oats, or rape, all of which were conveniently near the piggery. As the amount of this fed per day was so inconsiderable, no account was kept of it. At the same time, we have found that even a very little green feed fed regularly, as above mentioned, is a most beneficial thing for pigs. The pigs were fed in rather small pens with small outyards ; and during the latter part of the experiment they were cramped for room.

In the table presented below are given, in addition to other material, the gains in weight and the cost of producing 100 pounds of gain. In estimating the cost, meal is valued at $20 per ton, tankage at $33 per ton, blood meal at $55 per ton, and milk at 10 cents per hundred weight.

Group.	Gain.	Food consumed.	Food consumed for 100 lbs. gain.	Cost of 100 lbs. gain.
				$ c.
1	817 lbs....	2,884 lbs. meal ; 227 lbs. blood meal..	353 meal ; 27.78 blood meal..... ..	4 29
2	790 "	3,015 " ; 227 lbs. tankage....	381.64 meal ; 28.73 tankage.....	4 29
3	716 "	2,680 " ; 147 "	374 3 " ; 20.53 "	4 08
4	712 "	3,266 " ; 5,804 lbs. milk.....	458.7 " ; 815.16 milk.....	5 40
5	744 "	3,014 " ; 5,465 lbs. milk.....	405.1 " ; 734.54 milk..	4 78
6	695 "	3,049 " ; 1,011 lbs. milk and 75 lbs. blood meal.....	438.7 " ; 144 milk;10 79 bld. meal	4 87
7	800 "	3,190 lbs. meal ; 984 lbs. milk and 75 lbs. tankage	398.75 " ; 123 milk ; 9.87 tankage.	4 87

Notes on the Above Table.

1. This is but a single experiment, and will have to be repeated several times before any reliable results can be announced ; and it must, therefore, be understood that the comments made below apply only to the pigs fed in this experiment.

2. Those pigs fed blood meal or tankage produced gains more cheaply and at a less consumption of meal (middlings and barley) per 100 pounds than the ones fed skim-milk.

3. In group 6 (pigs fed meal, skim-milk, and blood meal) were two short, chubby pigs that were really finished some time before the conclusion of the experiment, a fact which accounts, in a measure, for the somewhat higher cost of feeding this group than group 7 (pigs fed meal, skim-milk, and tankage).

4. Even the small amount of blood meal or tankage fed along with skim-milk to groups 6 and 7 seemed to have a very beneficial effect.

5. The pigs, without exception, took to the blood meal and tankage from the very first with great avidity.

6. There is nothing in this experiment to indicate which is the more valuable food, blood meal or tankage.

7. In both cases where light weight pigs were fed in comparison with heavier pigs, cheaper gains were made by the former.

8. The duration of the experiment was 137 days, and the average gain per hog from beginning to end was 1 1-10 pounds per day.

On November 3rd all the hogs fed in this experiment were delivered to the Wm. Davies Company, Toronto, where the sides were marked, and carefully examined after they came out of the salt some three weeks later. Below is the report upon the sides :

"In regard to the shipment of hogs which you asked us to follow through the salt, we have only a meagre report to make, but that is eminently satisfactory, so far as the quality of bacon is concerned. Out of the whole shipment there was not a single hog which did not yield firm bacon which was graded by our inspector as 'best !' "

In conclusion : Blood meal and tankage have proven themselves fully equal to skim-milk for the production of firm bacon, and, so far as this experiment is concerned, have produced cheaper gains.

Even the small amount of green feed fed at noon seems to have been most beneficial.

Feeding Pigs Three Times per Day.

In the opening paragraph of this report upon hogs, it is stated that an attempt was made to feed the ordinary commercial blood meal to hogs. Two pens of five pigs each were used for this purpose. From the first these pigs showed their aversion to the food and after a three weeks' trial it had to be dropped. Two weeks later, when these pigs had come around to their normal condition and averaged in weight about 50 pounds each, they were fed a grain and skim-milk ration three times per day. One pig, for which the previous ration had proved too much, had to be left out, so that there were 9 pigs in the experiment. The feeding period for these pigs from this date was 101 days. The table below indicates the gains, food consumed, and cost of gains.

Gain.	Food consumed.	Food for 100 lbs. gain.	Cost of 100 lbs. gain.
1,224 lbs...	5,278 meal ; 11,094 skim milk.....	431 2 meal ; 906.3 skim milk.....	$ c. 5 21

Notes.

1. These pigs made slightly more rapid gains than any of the others. Although they were considerably below the others at the beginning, due to the unpalatable food at first fed them, yet, in the end, they were rather heavier than any of the others. They averaged a gain of 1 1-3 pounds each per day.

2. They consumed about the same amount of food per 100 pounds gain as groups 4 and 5, which were fed upon the same food.

3. However, judging from this experiment alone, we note that the extra gain was not sufficient to pay for the extra labor of feeding.

4. We purpose experimenting along this line next year with younger pigs and perhaps the results may be different.

5. From this experiment it is evident that where gains alone, irrespective of cost, are aimed at, as in the case of some "show stock," feeding three times a day or possibly more is good practice.

Short Keep vs. Long Keep Steers.

In the winter of 1901-1902, an experiment was conducted, with a view to determining the relative profits from buying moderately heavy fleshy steers which can be made ready for export by February or March, or from buying lighter, thinner steers which must be kept until May or June. The short keep steer costs more per pound than the thinner steer ; but, on the other hand, we have less labor and quicker returns in his favor. This line of experimental work has been continued during the past year, with a view to determining the reliability of the previous experiment, and below will be found a statement indicating the relative amounts of food required for, and the cost of, producing one hundred pounds gain in each case. The questions of market and labor will be left out of consideration at present.

Of the 16 steers used for experimental purposes, 8 of the larger and fleshier steers were selected to represent short keep animals, and were fed with the object of having them ready for market not later than March ; and the remaining 8 were fed with the object of marketing in May or June.

The short keep steers had to be fed a heavier meal-ration than the long keep steers in order to get them ready for market in time. The weights and average meal rations of the two groups were as follows :

Group.	Average weight at beginning.	Average weight at conclusion.	Average meal ration per day.	Amount meal fed per 100 lbs. average live weight.
Long-keep	1,098 lbs	1,445 lbs	6.6 lbs.	.52 lbs.
Short-keep	1,271 "	1,513 "	11.23 lbs.	.81 "

The long-keep steers were fed from November 29th to May 9th, or 160 days. The short-keep steers were fed from November 29th to March 26th, or 117 days.

The gains and food consumed for, and also cost of, 100 pounds gain are given below. In estimating the cost the following valuations have been employed: Meal, $20 per ton; hay, $8.00 per ton; and roots, $2.00 per ton,—all of which may be considered fairly high valuations.

Group.	Average gain per steer.	Average daily gain per steer.	Food consumed per 100 lbs. gain.	Cost of 100 lbs. gain.
				$ c.
Long-keep 160 days	347 lbs.	2 16 lbs	316 lbs. meal, 1,265 lbs. hay, and 2,316 lbs. roots	10 53
Short-keep 117 days	244 "	2.08 "	539 lbs. meal, 122 lbs. hay, and 2,480 lbs. roots	12 75

Notes.

1. The above figures do not represent the actual cost of feeding this bunch of steers, as they were allowed to run some two months upon a rape and grass pasture before being taken into the stables, during which time they made large gains very cheaply, and, were this taken into consideration, the cost of producing 100 pounds gain would be very much lowered.

2. It required about 200 pounds more meal for 100 pounds gain in the case of the short-keep steers than in the case of the long-keep steers.

3. Every pound of gain in live weight costs more to produce than it will sell for on the market. Any profit in feeding must come from increasing the value of the carcass purchased in the beginning. Therefore, the steer which requires to be increased in weight only 200 pounds in order to be fit for market, is worth considerably more per pound than the steer which requires to be increased 300 pounds. In this experiment, all the steers were sold at 5 cents per pound. In order to be paid for the food consumed at the valuation given above, we should have paid only $3.25 per cwt. for the long-keep steers, whereas we could have paid $3.50 per cwt. for the short-keep steers and realized the same values for the foods used.

Cut Feed vs. Uncut Feed.

The question is frequently asked: Does it pay to cut hay and roots? In our ordinary feeding we believe it does, because the cutting of feed enables us to mix in the ration straw, chaff, and inferior hay in a way that makes these palatable to the cattle. However, in feeding the above steers, hay and roots were the only roughage used, and both were of good average quality, so the opportunity was taken to determine, so far as this bunch of cattle was concerned, the relative gains from feeding good hay or roots whole or cut. Half of the long-keep and half of the short-keep steers were fed uncut hay and whole roots. The other half of each group were fed cut hay and pulped roots. The experiment was continued up to March 26th (119 days), when the short-keep steers were disposed of.

In the table below are given the gains made, the food consumed for 100 pounds gain, and the cost of producing 100 pounds gain under each system of feeding:

Group fed.	Average gain.	Average daily gain.	Feed for 100 lbs gain.	Cost of 100 lbs. gain.
	lbs.	lbs.		$ c.
Cut feed	242.5	2.04	416 lbs. meal, 1,112 lbs. hay and 2.224 lbs. roots.	10 82
Uncut feed	257	2.16	397 lbs. meal. 1,255 lbs. hay and 2,549 lbs. roots.	11 54

Notes.

1. Making no allowance for the cost of cutting hay and pulping roots, 100 pounds gain were produced at a cost, for food material, of 72 cents less in the case of using cut feed than in the case of using uncut feed.

2. The steers fed cut feed averaged in weight at the conclusion of the experiment 1,388 pounds, of which 242.5 pounds cost, as stated in note (1), 72 cents per 100 pounds less to produce. From this it is evident by a simple calculation that were steers generally selling at $5 per hundred weight, these steers could have been sold with as much profit at $4.87.

3. It will depend much upon circumstances, other work that could be done, etc., whether this is sufficient margin to pay for cutting hay and pulping roots.

Blood Meal to Narrow a Nutritive Rati .

In our account of experiments with hogs will be found a statement showing the high value of blood meal as a feed for hogs. A further test was made with blood meal by feeding it to steers in addition to their ordinary meal ration of corn meal, oats, and barley, with a view to determining the economy of narrowing the nutritive ratio by its use.

Steers averaging about 1,250 pounds, and that had already been fed about two months upon 6 to 8 pounds of meal, were divided into two groups of 8 each, one group being fed as before and the other getting in addition about 1 1-5 pounds per day each of blood meal. The experiment continued 63 days.

The following table shows the feed consumed and gains made :

Group.	Gain.	Feed consumed.	Feed for 100 lbs. gain.
	lbs.		
Fed blood meal.....	1,085	4.650 lbs. meal, 590 lbs. blood meal, 13,880 lbs. hay and 27,996 lbs. roots.	429 lbs. meal, 54 lbs. blood meal, 1,279 lbs. hay, and 2,580 lbs. roots.
Fed without blood meal	1,070	4,739 lbs. meal, 14,453 lbs. hay and 28,890 lbs. roots.	443 lbs. meal, 1,350 lbs. hay and 2,700 lbs. root.

Notes.

1. The steers getting blood and meal made slightly better gains than the others, and consumed a little less meal, hay, and roots per 100 pounds gain.

2. However, valuing the standard foods as above and blood meal at $33 per ton, it cost 34 cents more for a hundred weight of gain in the case of the steers fed blood meal and those not fed blood meal.

3. This is scarcely a fair test for blood meal as a food for cattle, as its greatest value no doubt is with young, growing cattle that need protein for developing muscle. Moreover, the results are in accord with our previous experiments, which have gone to show that light meal rations are more economical than heavier meal rations.

The Feeding of Range Steers.

Those who were in attendance at the Winter Fair of 1902 will remember a bunch of range steers that were on exhibition at the fair. In order to determine the profit from feeding this class of cattle, we fed nine of them at the experimental department. Two pens were arranged and the steers were fed loose in these pens from December 28th to May 24th, 147 days. During the last 6 weeks they were allowed the run of a small yard, into which they could go at liberty. The steers averaged in weight at the beginning of the experiment 980 pounds, and when finished weighed an average of 1,205 pounds.

The table below gives the total gain of the 9 steers, the average daily gain per steer, the food consumed during the whole feeding period, and the amount of food and cost of food to produce 100 pounds gain:

Total gain.	Average daily gain per steer.	Total feed consumed.	Feed consumed per 100 lbs. gain.	Cost of 100 lbs. gain.
lbs.	lbs.			$ c.
2,025	1.53	10,952 lbs. meal, 55,694 lbs. roots, 37,550 lbs. hay.	541.8 lbs. grain, 2,750 lbs. roots, 1,850 lbs. hay.	15 56

Notes.

1. So far as this experiment is concerned, it is evident that unless they could be bought at a very low rate, it would not pay to feed such steers as those experimented upon.

2. At the same time, it is worth noting that these steers made much better gains during the period they were allowed the run of a yard than when they were confined in their pens. Feeding in corrals is the system practised in the west, and it would appear that a similar system would have to be adopted in order to feed these steers successfully in Ontario.

Conclusion.

We hope that, in the near future, our facilities for conducting experimental work along live stock lines may be increased so that, not only more experiments may be conducted, but those that are conducted may be on a somewhat larger scale. We would also like to see arrangements made for extending this work outside of the College and for conducting experiments in the stables of some of our best feeders of live stock, so as not only to give corroboration to the work conducted at the College, but encourage the spirit of investigation to a greater extent among the practical feeders and breeders of the Province.

Respectfully submitted,

M. CUMMING,

Lecturer in Agriculture.

PART XI.

THE PROFESSOR OF HORTICULTURE.

To the President of the Ontario Agricultural College:

Sir,—I have the honor of presenting herewith my eleventh annual report on the work of the Horticultural Department.

In reviewing what has been accomplished during the year, I am pleased to state that steady progress has been made in nearly all lines of our work. While this is gratifying, yet we do not rest satisfied with present attainments, for this would put an end to all progress. Horticulture presents such an unlimited field for the work of investigation and of instruction that we feel we have made only a beginning, and that we would like to enlist all the help possible in a work which is at once pleasant and profitable.

Instruction of Students.

At an institution of this kind, which is both a College and an Experimental Station, our work must necessarily be of a twofold nature—that of education and that of investigation. For eight months of the year we are engaged the most of our time in the instruction of students, the other four months, with whatever time can be taken during the College sessions, is devoted to investigation work. Hence the College instructor naturally looks for his greatest results in what he spends most time upon,—his students. Our classes, both regular and special, are increasing yearly, and they necessarily require more of our attention. A comparison of our last year's time table with that of ten years ago, shows that we are now giving ten times the time to horticulture on our College curriculum that we did then.

As a full outline of the course in horticulture is given in the College circular, and reference has been made to special features of it at various times in our annual report, we need make no further reference to it here, except to say that we are endeavoring to make the course as practical as possible and more and more complete, and we look for the results among our ex-students throughout the country, in better managed orchards, more numerous and better tilled vegetable gardens, more beautiful country homes, more farm windbreaks and carefully managed wood lots, and more useful and intelligent members of the community generally.

Correspondence.

One of the signs of growing confidence in the work of the College, is the ever increasing number of letters sent in, asking for all kinds of information. Nearly every mail brings letters enquiring about the best varieties of fruit to plant; the best time and method of pruning; what spraying mixtures to use; and a hundred and one other such questions relating to all kinds of horticultural work. About a thousand letters have been written during the year answering such questions.

Meetings Attended.

During the year I attended and took part in the programme at the following public meetings:

Seven meetings of the Guelph Horticultural Society and addresses on various horticultural topics.

The Hamilton Horticultural Society, address on "The Growth and Development of Fruiting Branches."

Central Exhibition at Guelph, judging display of fruits.

Northern Model Fair at Walkerton, address and judging display of fruits.

Centre Wellington and Nichol Agricultural Societies at Fergus, judging Horticultural display.

North Waterloo Agricultural and Horticultural Exhibition at Berlin, judging display of fruits.

Niagara County, N.Y., Farmers' Club, address on "The Work of the Ontario Agricultural College, and Improved Methods of Fruit Growing."

The St. Joseph Island, Farmers' Institute at Hilton, address on "The Possibilities of Fruit Growing on the Island."

Ontario Fruit Growers' Association at Leamington, address on "The Beautifying of Home Grounds," and report on "New Fruits."

Convention of Agricultural Colleges and Experiment Stations at Washington, D.C., address on "Practical Instruction in Horticulture."

Ontario Agricultural and Experimental Union at Guelph: Report on co-operative testing of small fruits and report as Treasurer of the Experimental Union.

Reports and Articles Published.

For the Fruit Experiment Station Report I prepared a report on my annual inspection of the stations.

For the Ontario Fruit Growers' Report I prepared a report on the new and seedling fruits of the year, and a paper on the "Beautifying of Country Homes."

For the Experimental Union Report I prepared a report on our co-operative testing of small fruits throughout the Province.

For the Canadian Horticulturist I prepared articles on: "The Cold-Storage of Fruits"; "The Preservation of Fruits for Exhibition Purposes"; "Notes on Fruit Growing in the North"; "Growing Rhubarb in the Cellar in Winter"; and answers to numerous questions of correspondents.

Inspection of Fruit Experiment Stations.

The fourteen Fruit Experiment Stations, located in as many different parts of the Province, are under the joint control of the College and the Fruit Growers' Association. As Official Inspector, it is my duty to inspect each of these stations and to report upon the same to the Board of Control. Each was visited at the most opportune time throughout the summer to take note of the fruits under test, and a number of photographs were taken which will be useful in illustrating the reports of the experimenters. For a fuller account of this work I may refer to the annual report of the stations.

Co-operative Testing of Small Fruits.

For the past ten years we have been carrying on a series of co-operative experiments with small fruits. This work was begun on a small scale, but it has steadily increased until we now have on our books the names of about 1,300 experimenters who have engaged in this testing.

The following is the list of plants offered for testing last spring:

I. Strawberries—Clyde, Tennessee Prolific, Irene and Van Deman—12 plants of each.

II. Raspberries—Cuthbert, Golden Queen, Marlboro', and Columbian—6 plants of each.

III. Black Raspberries—Gregg, Kansas, Palmer, and Souhegan—6 plants of each.

IV. Blackberries—Agawam, Gainor, Kittatinny, and Snyder—6 plants of each.

V. Currants—Fay, Raby Castle, Victoria, and White Grape—2 plants of each.

VI. Black Currants—Champion, Lees, Naples, and Black Victoria—2 plants of each.

VII. Gooseberries—Downing, Pearl, Red Jacket, and Whitesmith—2 plants of each.

The varieties selected are those which have been found by repeated tests at the College and at the Fruit Experiment Stations to be among the best to give a long season of fruiting from early to late.

The number of plants for each experiment is just enough to afford a comparison of the varieties, and gives the experimenter a start if he wishes to propagate more. The number may seem small, but when we take into account what is sent out each year, it is surprising how fast these figures count up. During the past ten years we have distributed throughout the Province 344 black currant bushes, 3,066 red and white currant bushes, 3,908 gooseberry bushes, 5,396 blackberry bushes, 6,648 red and white raspberry bushes, 6,744 black raspberry bushes 37,584 strawberry plants, making a total of 63,690 plants.

For a fuller report on this work the reader is referred to the Report of the Experimental Union.

Experimental Work at the College.

The extensive variety tests which we have been conducting for several years past with strawberries, raspberries, blackberries, currants, gooseberries, and tomatoes were continued again this year.

Tests have also been under way for some time with the larger fruits, such as apples, pears, plums, peaches, cherries, quinces, and grapes. A new experiment was begun on a large scale with orchard cover crops, and in conjunction with the Department of Physics, the experiments begun last year with fruits in cold-storage were continued this year in our own cold-storage plant on a much larger scale.

Orchard Cover Crops.

The following report on an experiment with orchard cover crops is presented by H. S. Peart, B.S.A., assistant in this department, who carried out the details of the experiment :

During the past season a number of cover crops for orchard purposes have been tried. A brief account of the growth of these is here given :

In the spring, as soon as dry enough to permit, the ground was plowed about four or five inches deep. Cultivation was begun immediately, and the whole ground gone over every week or ten days, depending somewhat on the weather, until the end of July. The thorough cultivation kept the ground fairly free from weeds, and tended to conserve soil moisture. On July 31st the seed for the following crops was sown and covered with a light harrow :

The seed germinated quite readily, and the growth of each was noted during the summer and early autumn. On November 4th, just before the hard freezing weather set in, the growth and condition of each was fully noted.

No. 1. Red Clover. Sown at the rate of 15 pounds per acre formed a mat about 3 inches thick. This is a very fair cover, but would be better if somewhat thicker. Twenty pounds per acre would probably be better.

No. 2. Mammoth Clover. Sown at same rate as red clover. Very little difference could be noted between this and the red clover.

No. 3. Crimson Clover. Sown at the rate of 20 pounds per acre reached a height of about three inches, but did not form so close a mat, and was not so strong as the red or mammoth clover. The seeding was much too thin for the best results. One-half bushel is required for a good cover in this locality.

No. 4. Hairy Vetch. Sown at the rate of 40 pounds per acre formed a low dense mat about two inches high. The low growth of this plant is a decided advantage, as it does not inconvenience fruit pickers in the autumn. It is probable that a somewhat lighter seeding of about 30-35 pounds would give quite as good results.

No. 5. Alfalfa. Sown at the rate of 30 pounds per acre grew to a height of six-seven inches and stood up well, making a good cover. The quantity of seed in this case appears to be about right.

No. 6. Rye. Sown at the rate of 1½ bushels per acre grew to a length of about twenty inches, but went down and formed a mat about six inches thick. This is a very desirable cover. The seeding is about right, although on very strong land, 1¼ bushels should be ample.

No. 7. Rape. Sown at the rate of 10 pounds per acre formed a very rank growth in the low ground, reaching a height of nearly two feet. On the gravelly ridge running through the orchard it was somewhat shorter. Rape is evidently not well adapted to gravelly knolls. The seeding was thicker than necessary, about 8 pounds per acre should on most orchard lands give good results.

No. 8. Hairy Vetch 40 pounds, and Rye 30 pounds, per acre. On the high land the hairy vetch formed a very good cover and was ahead of the rye. On the low ground the vetch was smothered by the rank growth of the rye, which grew 7-8 inches This is not a desirable combination.

No. 9. Hairy Vetch 20 pounds, and Cow Horn Turnip 12 ounces, per acre. The turnips made good roots, and the tops stood about 14 inches, but completely smothered the vetch. The turnips are not so desirable as some of the other crops.

No. 10. Hairy Vetch 20 pounds, Crimson Clover 8 pounds, and Cow Horn Turnips 8½ ounces per acre. The vetch and clover formed an evenly mixed mat about 3 inches high, but was too thin to sufficiently cover the ground. The turnips were somewhat unevenly distributed, and in some places had smothered out the vetch and clover.

No. 11. The same mixture as the preceding, except that no turnips were used. The seeding was rather light. A better stand would have been made if more seed had been used.

No. 12. Hairy Vetch 20 pounds and Red Clover 8 pounds per acre. This formed a very thin, weak cover. The seeding was much too light.

No. 13. Hairy Vetch 20 pounds and Mammoth Clover 8 pounds per acre. Here, again, the seeding was too light for the best results.

No. 14. Rye 1 bushel and Rape 4 pounds per acre. The rape grew to about 20 inches and the rye was almost smothered out.. It is doubtful if any other crop can be successfully used in combination with rape.

No. 15. Alfalfa 15 pounds and Red Clover 8 pounds per acre. This combination appears very satisfactory, the growth was about 8 inches and moderately thick.

No. 16. Alfalfa 15 pounds and Mammoth Clover 8 pounds. The condition was very similar to that of the preceding plot.

No. 17. Alfalfa 15 pounds and Crimson Clover 8 pounds. Much like the preceding plot, except that the alfalfa seemed somewhat too vigorous for the clover.

From the above notes it may be seen that most of these crops will give better results when used alone. When two are used, one almost invariably checks the other, and as a consequence the seed for one of the plants is lost.

These crops will be noted again in the spring, and the condition in which they come through the winter will be reported on later.

Apples.

The past has been on the whole an excellent season for apples. On all of our old trees there was a heavy crop, and in the young orchard set out seven years ago the trees of many varieties are coming into bearing. Thirty-six varieties began bearing last year, and this year there was fruit on fifty-six varieties. Orchard note books have

been prepared in which careful records are being kept of the growth, blooming, and fruiting of every tree in the orchard. This in a few years will give a lot of valuable data. For the present we shall merely mention those varieties which have fruited so far, classifying them according as they bore heavy, medium, or light crops. The varieties which bore for the first time this year are marked with an asterisk.

Those varieties fruiting heavily this year were: Benoni, Duchess, Gano, *North West Greening, Ontario, Peter, *Seek-no-Further, Shackleford, Stark, *Tetofsky, Walbridge, and *Yellow Transparent.

Those which bore a medium crop were : Ben Davis, *Early Harvest, Fallawater, Haas, *Jonathan, Longfield, *McIntosh.

The following bore only a light crop : *Astrachan, Baxter, *Belle de Boskoop, *Belleflower, *Bethel, Cooper's Market, *Fall Sweet, Gideon, *Golden Russett, *Golden Sweet, *Grimes, Hare Pipka, Hubbardston, Hurlburt, Magog, Maiden's Blush, *McMahon, *Pewaukee, *Ribston, *Rhode Island Greening, *Roxbury Russett, *Salome, *Scott's Winter, *Sutton Beauty, Tallman, Trenton, Utter, Wagener, Wealthy, Wellington, *Winter St. Lawrence, and all of the crab apples, viz.: General Grant, Hyslop, Martha, Montreal, Transcendent, and Whitney.

Pears.

We have in our experimental orchard about thirty-three varieties of pears, in all about one hundred and twenty trees. Some varieties have made very fair growth and are doing as well as we could expect in this section, where the winters are rather severe for pears, but others are beginning to show clearly that they lack the vigor and hardiness to stand our climate.

The following varieties bore a light crop this year; those marked with an asterisk fruited also last year : Bartlett, Bessemianka, Doyenne d'ete, *Flemish Beauty, Howell, *Kieffer, Lawrence, *Manning's Elizabeth, and *Seckel.

The following varieties fruited last year, but not this : Easter Beurre, Giffard, Lawrence, and Lincoln.

Plums.

The varieties of plums grown in this country may be grouped under three more or less distinct types : The Americana or Native varieties, many of which have been introduced during the past ten or fifteen years. One of the chief characteristics of this type is their extreme hardiness. They may be grown where the other types will not succeed at all, and apparently do best under such conditions. We have about two dozen of these varieties in our collection, most of the trees of which are young and not yet in bearing.

The following bore a light crop this year : Bender, De Sota, Hawkeye, Stoddard, and Weaver.

The Domestica or European varieties are those which for many years past have been the most extensively grown in this country. They are not nearly so hardy as the native varieties, but are usually considered of better quality, although in this respect as well as in size and color they present a much greater variation. Of this class of plums the Glass, Lombard, and Victoria bore heavily this year. Grand Duke and Gueii bore a medium crop, and the following varieties bore a light crop : Coe's Golden Drop, Field, Monarch, Moore's Arctic, Reine Claude, Shipper's Pride, Smith's Orleans, and Shropshire Damson.

The Japan plums are of a comparatively new type in this country and it was at first supposed they would not be any hardier than the peach, but experience has shown that they are much more hardy than was generally supposed. The Burbank and Abundance, which are the most generally grown varieties of this class, have been fruited here for the past four years, and have been the most vigorous and productive varieties in the orchard.

Cherries.

We have in our experimental orchard about thirty varieties of cherries, in all about one hundred trees.

Those varieties of the Morello type have as a rule made the most satisfactory growth, because of their extreme hardiness.

The following varieties bore fruit this year : Early Richmond, Montmorency, Olevet, and Vladimer.

Many of those of the Heart and Bigarreau type, commonly known as the English cherries, are showing signs of being tender for this section, although the following varieties bore some fruit this year : Black Heart, Governor Wood, Schmidt's Bigarreau, Windsor, and Yellow Spanish.

Another class of cherries,—the Dukes,— which are often classed with the Morellos, are intermediate between the two classes just mentioned, both in habit of growth and hardiness.

The following varieties of this class bore fruit this year : Belle Magnifique, Dyhouse, Empress Eugene, and Late Duke.

Strawberries.

For the past eight years we have been conducting an extensive variety test with strawberries, during which time over 300 varieties have been on trial. Each variety has been given at least five years' trial before it has been discarded, unless it has shown clearly that it was not worthy of so long a trial. A number of the leading varieties have been retained from the beginning which form a standard for the comparison of newer varieties, which are being introduced each year. Fifty new varieties were added to our collection this year. Careful notes have been taken upon the habits of the plants, and the character of the fruit, and every picking has been carefully weighed and recorded. In this way much valuable data has been obtained, and we now have a fairly good idea of the value of a great many varieties grown under our conditions.

Too often the first question asked by the inexperienced grower about strawberries is : "Which is the best variety to plant ?" This is a question too indefinite to be satisfactorily answered, for there are so many desirable characters sought for in a strawberry, and so few varieties that possess more than one or two of them, that we must know first what kind of a berry is particularly desired. If we were asked, which on the whole has been our most productive berry ; our largest berry ; the best table or canning berry ; the earliest or latest berry,—the answer could be given much more satisfactorily.

In the following list a dozen of the most desirable varieties are given which cover the season from early to late :

Early : Splendid, Wesley, Van Deman, and Sadie.

Midseason : Clyde, Warfield, Haverland, Williams, and Tennessee Prolific.

Late : Irene, Saunders, and Buster.

If we were to reduce the above list to four varieties and no collection, either for home use or market, should have less than this, we would select for this section : Splendid, Clyde, Warfield, and Irene. The first two are perfect flowering varieties, while the last two are imperfect.

Raspberries.

Sixty varieties of raspberries have been under test here for several years, and each year careful records have been made of the weight of each picking from each variety. This year the crop was so light and uneven that we found it more practicable to make a general estimate of the relative standing of the varieties than to follow up our practice of weighing. As a result of several years' testing and careful observations the following have proved to be the most satisfactory varieties here :

Red : Cuthbert, Marlboro', and Loudon.
Purple : Columbian.
White : Golden Queen.
Black : Older, Eureka, and Smith's Giant.

Currants.

We have now an excellent two-year-old plantation of currants of about seven hundred bushes, in which forty-six varieties—twenty-one red, twenty-two black, and three white—are under test.

All of them bore fruit this year, Red Cross being the heaviest yielding red variety, Black Victoria the heaviest yielding black, and White Grape the most productive white variety.

The Red Cross is a large, showy currant of good quality, and while it may not hold its place over Fay and Cherry and Victoria, which have as a result of the previous tests been the favorites, still it is a very promising variety.

The White Grape has always been our best white currant, and has always been the most productive variety in our whole collection. Black Victoria is a comparatively new variety, but it bids fair to surpass all of the old varieties, such as Champion, Lees, and Naples, which have so long been the standards.

Gooseberries.

We have in our gooseberry plantation forty-five varieties of gooseberries, twelve of which have been under test for seven years. The crop was light this year on all varieties, but the results tend to confirm those already reported for previous years. Pearl and Downing still head the list as the most productive and best all round varieties, and they are so nearly alike that the planter will make no mistake in planting either of them. Red Jacket ranks next for general value. It is not quite so productive as Pearl or Downing, but the fruit is about one-half larger.

All of these are American varieties, and are more or less exempt from the mildew to which the English varieties are so subject.

Tomatoes.

The past two summers have been unusually unfavorable for the ripening of tomatoes. The cool moist weather kept the vines growing vigorously, but they did not mature one-half of the crop, and what crop did ripen lacked the flavor of fruit ripened in ordinary seasons.

These unfavorable weather conditions have emphasized the value of early varieties, particularly for sections such as this, where the late varieties cannot be depended upon to ripen the fruit.

We have been conducting a variety test with tomatoes for six years past, in which fifty varieties have been carefully tested. Earliana, a new variety, the seed of which was obtained from three different seedsmen, as their special variety, heads the list not only for earliness but for total crop. This is a smooth, red tomato of medium size and more than average firmness. In earliness and productiveness it was closely followed by Mayflower, Dominion Day, Atlantic Prize, and Earliest of All, which rank in the order named for total yield of ripe fruit. These varieties have for several years past stood out prominently among the best for this locality, and reports from elsewhere show that they are the favorites in most localities where tomatoes are largely grown for the market.

Cold Storage.

Since the completion of the cold storage plant here, we have been carrying on in connection with the Department of Physics a series of experiments with the cold storage of fruits. These began with strawberries, raspberries, and the bush fruits, and have

been followed up throughout the season with grapes, peaches, plums, pears, and apples kept at different temperature. The apples, pears, and peaches being put up in different styles of packages. On the whole very satisfactory results have been obtained. But as some of these experiments with apples and pears which are still in storage will probably not be completed before next summer, we shall defer publishing results until they can be given in full.

Wax Models.

We have been fortunate in securing the services of Mrs. Stanley Potter, an artist of continental reputation, who has been with us for the past year and a half preparing a collection of wax models of fruits and vegetables. Already she has done for us over three hundred and fifty models of the leading varieties of fruits and vegetables.

These models are done with such wonderful skill that it is often difficult to distinguish the model from the natural specimen from which it is made. Many a time our visitors have been deceived in thinking that the whole collection was made up of natural fruits preserved in some way from decay.

Such a collection for class work and exhibition purposes is from an educational standpoint of inestimable value, and we hope to retain Mrs. Potter for this work until we have a fairly complete collection of the most valuable varieties of Ontario grown fruits and vegetables.

Acknowledgements and Needs.

In concluding, I wish to acknowledge the faithful services of those who have labored throughout the year to keep up the work of the department. William Squirrel, who has been here since the College opened twenty-nine years ago, has charge of the gardens and grounds, and their neat and tidy appearance at all times has been largely due to his constant watchfulness and diligence. William Hunt, our new florist, has proved himself to be the right man in the right place. His skill in the management of plants, and the ability and ease with which he imparts his information to students and visitors, makes him a valuable acquisition to this department.

Mr. H. S. Peart, who obtained his degree of B.S.A. last June, and was immediately appointed as fellow in this department, has been doing excellent work. I have all confidence in his ability that he will prove to be just the man we have been looking for.

One of the most urgent needs of this, as well as of other departments employing labor, is convenient living accommodation for such help. We are in great need of at least three small houses for teamsters and night fireman. Without such accommodation it is almost impossible to get or keep the right kind of help. We trust that suitable and convenient houses for this purpose will soon be provided.

Respectfully submitted,

H. L. HUTT,

Professor of Horticulture.

PART XII.

THE PROFESSOR OF BACTERIOLOGY.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to submit herewith my report on the last year's work in the Bacteriological Department.

LECTURES

The following courses of lectures to our regular students were given during the year : (1) A course of thirty lectures on Bacteriology in its relation to agriculture and dairying for second-year students ; (2) a more advanced course on the relation of bacteria to agriculture and the infective diseases of animals for fourth-year students ; (3) a special course of lectures on the bacterial diseases of plants and the bacterial decomposition of fruits, vegetables, and other plant substances to the fourth-year specialists in biology and horticulture ; (4) a rather extensive course of lectures and laboratory work on dairy bacteriology to the fourth-year specialists in dairying.

In addition to the above, the following lectures, with laboratory work, were given to our short course and special students in attendance during the year : (1) To the special dairy class, which is here for three months, a course of ten lectures and a two-weeks' laboratory course. On account of the large size of this class and the small laboratory accommodation at my disposal, I had to repeat the laboratory work four times in order to give all members of the class the same instruction. This entailed a great waste of time, and I hope that additional accommodation will be provided for this work in the near future ; (2) a short course of lectures and laboratory work to the students in the special creamery course; (3) a course of lectures and laboratory work for the dairy instructors who have the control of the inspection of creameries and cheese factories during the summer under the supervision of the Superintendent of Farmers' Institutes ; (4) a few lectures and considerable laboratory work for the Macdonald teachers in Nature Study, who studied here during a part of the late summer ; (5) special lectures and laboratory work to students who have specialized along certain lines, as, for example, Mr. C. F. Whitley, of the Dominion dairy service, spent a week or two in my laboratory studying moulds and certain bacterological problems in connection with dairying ; (6) special laboratory work, involving a good deal of superintendence, was given to fourth-year specialists in agriculture, who have elected to take their thesis work in my department ; (7) four lectures, with demonstrations, to the students in the short course on Poultry Raising.

MEETINGS ATTENDED.

During the year I attended a number of conventions, and delivered addresses before several meetings and associations, as follows :

1. The Dairymen's Association of Western Ontario. Address : "Injurious Flavors in Cheese."

2. The Technical School of the Dominion Master Bakers' Association. Two lectures on the "Fermentation of Bread," etc.

3. The Second Annual Meeting of the Dominion Master Bakers' Association. Address : "The Abnormal Fermentations of Bread."

4. Master Bakers' Association of the United States of America, Philadelphia meeting. Address : "The Impurities of Wheat and Flour and the Diseases of Bread."

5. The Canadian Institute. Address : on the " Bacterial Contamination of Milk and its Control."

6. Ontario Fruit Growers' Association. Address: "Pear, or Fire, Blight."

7. The American Public Health Association. Paper : on the " Supposed Identity of Human and Avian Diphtheria."

8. Short-course students in live stock judging. Address: "The Practical Results of Bacteriology."

9. Convention of Dairy Experts at Ottawa. Address: " Bacteriological Notes for 1903."

Publications.

During the year the Ontario Department of Agriculture have issued, or are issuing, the following bulletins :

Bulletin 125. By my former assistant, H. Streit, D.V.M., and myself upon " Roup, an Infectious Disease of Fowls " ; and a more scientific study of the same disease was issued as Bulletin 132, " Roup, an Experimental Study."

The bacteriological results in the ripening of cheese in cold-storage, compared with ripening in an ordinary curing room, work which has extended over the last three or four years has been written up and similar work done by Dr. W. T. Connell, Professor of Pathology in Queen's University, Kingston, have been combined, and issued in bulletin form by the Ontario Department of Agriculture, under the title, " The Bacterial Content of Cheese Ripened at Different Temperatures," by F. C. Harrison and W. T. Connell. This paper has also been published by the " Revue Generale du Lait " of Brussels, Belgium.

The Bureau of Animal Industry of the United States Department of Agriculture also published, in their nineteenth annual report, a paper of mine on the " Duration of the Life of the Tubercule Bacillus in Cheese." This article is submitted for publication in this report of the College.

Less important articles and notes were contributed during the year to various Canadian agricultural periodicals.

Routine Laboratory Work and Analysis.

During the year (January 1st to December 31st) we have manufactured and sent out 252 doses of tuberculin, 4 doses of mallein, and 187 pure cultures or starters, for cheese and butter-makers.

We have also made bacteriological analyses, or diagnoses, of the following substances, and have reported the results to those sending in the material :

Cheese	6	Water	5
Sputum	3	Peritoneal exudation	1
Pigs—Post mortem, 2; diseased, 4;	6	Black Swan	1
Pork	2	Butter paper	1
Suspected anthrax	6	Fleece from sheep	1
Pus (human)	4	Suspected tetanus	1
Diseased tissue (horses)	5	Diseased bee larvae	2
Tuberculosis, cattle	2	Meal, suspected food poisoning	1
Cream and milk	31	Suspected quarter evil	1
Tumors, bovine	3	Whey	1
Dogs	1	Blood	1
Cows—Post mortem	3	Urine	2
Mastitis	1	Butter	1
Suspected diphtheria	8		
Fowls	18	Total	135
Chickens	17		

As we frequently get inquiries about the manner in which specimens should be sent, the note regarding the assistance offered to veterinarians and farmers, printed on page 88 of last year's report, is again inserted :

Assistance Offered to Veterinarians and Farmers.

In cases of diseases, send the organs or material carefully wrapped in an antiseptic wrapper, giving full particulars regarding it. It is best to send by express; and in summer it may be necessary to pack in ice.

In cases supposed to be, or suspected of being:

Anthrax. Send an ear, or some of the blood, spleen, or liver of the dead animal.

Symptomatic Anthrax, Black-leg, or Quarter Evil. Send the parts infected, as this disease is usually in the muscles.

Malignant Oedema (similar to black-leg, but showing more fluid in the subcutaneous tissues, which, unlike the fluid found in cases of black-leg, is almost colorless). Send the parts affected.

Tetanus or Lockjaw. On account of the difficulty of finding the bacillus of this disease, it is almost useless to send material, unless the point of inoculation is known, in which case cut away and send the flesh around the point of inoculation.

Glanders (a disease which affects either the nasal passages or the skin, in the latter case called Farcy). Send some of the ulcers from the parts infected, or of the discharge from the nasal passages.

Hog Cholera and Swine Plague. Send any diseased portions of the animal.

Actinomycosis, or Lumpy Jaw. Send in a bottle a little of the matter found in the tumor mass.

Rabies, or Hydrophobia. Send the base of the brain of medulla oblongata of the animal suspected.

Tuberculosis and Pseudo-Tuberculosis. Send any tubercules or diseased glands.

Mammitis, or Inflammation of the Udder. Send a sample of the milk in a clean bottle that has been boiled in water.

In cases of diseases affecting poultry, such as Chicken Cholera, Roup, Tuberculosis, or Blackhead, send the whole bird.

Assistance.

I regret to report that H. Streit, D.V.M., resigned his position as assistant in this department in order to take up a veterinary practice in partnership with his father at his home in Zimmerwald. Dr. Streit has proved a willing, faithful, and very competent assistant, and I much regret having lost his services. Considerable difficulty was experienced in obtaining a suitable person to fill his place; and it was not until the beginning of November that I succeeded in obtaining an assistant, when Mr. Bronson Barlow, Assistant Bacteriologist in the Michigan Experiment Station, was appointed. Mr. Barlow was very highly recommended by Dr. Charles E. Marshall, Professor of Bacteriology and Hygiene, at the Michigan Agricultural College, and I feel sure that his work will be appreciated by our own students and the farmers of the Province.

Urgent Needs.

In my last year's report, I called your attention to the need of more room for practical work in bacteriology. The ever-increasing number of students; the diversity of the work in which we are engaged (Bacteriology in its relations with Horticulture, Live Stock, and Dairying, Fermentation Problems in bread-making, cider-making, vinegar-making, etc.); and the establishment of the Macdonald School for Domestic Science—have all contributed towards making the need of increased accommodation more urgent than ever. With our present accommodation, it is impossible to handle more than one class at a time, so we have the inconvenience of dividing and sub-dividing classes, and the loss of time caused by repeating laboratory work for the dairy students is very great. I feel that it is impossible to do justice to the various classes of students with

our present laboratory facilities, and I would respectfully call your attention to the fact that two of the leading agricultural institutions in the United States—the Agricultural Department of Wisconsin University and Experiment Station and the Michigan Agricultural College—have recently erected and equipped complete bacteriological laboratories for instruction and research. The Wisconsin laboratory cost about $50,000; and that of the Michigan Agricultural College cost $35,000 for the building, and $20,000 for the equipment placed in it. Several Agricultural Colleges in the United States have in prospect buildings similar to these, to cost from $30,000 to $75,000. In view of these facts, I think it is time that the Ontario Agricultural College had a separate building for bacteriological work, as the need of laboratories for instruction is very great, and the field for research work is so wide and the demands so numerous that something ought to be done at once. In proof of these statements, I may mention a few of the problems upon which we have been engaged to show the diversity of the work which has already been done in this department: Bacterial diseases of bees; infectious diseases of poultry; studies in bovine tuberculosis; problems relating to dairying—the abnormal fermentations of butter, milk, and cheese; the manufacture of tuberculin and mallein; the preparation of pure cultures for cheese and butter-makers; the normal and abnormal fermentations of dough and bread; the bacterial diseases of plants; studies in cider-making; and the analysis of water. See also on page 97 a list of 135 examinations made during the year for farmers, veterinarians, and others who have sent materials of various kinds to the laboratory.

Research Work.

On account of my being without an assistant from March till November, the research work undertaken during the year has been confined chiefly to the solution of problems already on hand. Not much new work has been undertaken. The routine laboratory work has engrossed most of my attention. Mention has already been made of the work upon the bacterial content of normal Canadian cheddar cheese; and, in addition to this, one of the commonest abnormal fermentations of cheese—the gaseous fermentation—has been studied. Some work has also been done upon the slimy, or "ropy," fermentations of milk. This affection seems to be rather common in some parts of the Province; and we have isolated several organisms which produce the slimy condition in ordinary milk supplied for household use.

Some studies have also been made of the bacterial decomposition of roots,—an affection which seems to be of considerable importance, as many farmers in different parts of the Province have reported a considerable amount of rot in stored turnips. Pear, twig, or fire blight, as it is variously termed, was also very common during the growing season in the Niagara and Grimsby districts; and, in consequence of this, an address on the subject was given at the annual meeting of the Ontario Fruit Growers' Association. This address will be published in the report of that Association for 1903.

It is pleasing to be able to record the growing interest taken by the bakers of the Province in fermentation subjects, as evidenced by the formation of a technical school for baking; and I quote a few paragraphs from an editorial in the "Canadian Baker and Confectioner" regarding the establishment and success of this school:

The Bakers' School.

"The two days' school of Technology in Baking and Bakery Methods held in Toronto on April 29th and 30th, forms a unique event in the history of the Canadian baking trades. It is one that promises to develop results that will have an important bearing on the future of the bread industry in Canada. This two days' course of technical study as applied in the making of bread is the first of the kind recorded on this continent. Bakers' associations in a number of the States in the Union have agitated for soemthing of this nature, but it remained for the Provincial Government of Ontario, through the agitation of some of the active members of the Cana-

dian Master Bakers' Association, together with the Baker and Confectioner, to bring about the consummation reached last month.

"At the convention of last year, which was naturally largely experimental in its nature, the bakers in attendance evinced so keen an interest in technical education that those most actively concerned were encouraged to seek the aid of the Provincial Government in establishing regular institutions. Accordingly, in February last the Executive Committee of the Canadian Master Bakers' Association, with a number of other bakers and millers, interviewed the Hon. John Dryden, Minister of Agriculture, and Mr. C. C. James, the Deputy Minister, and put the desires of the baking trade before them.

"As a result, the Ontario Government agreed that Professors F. C. Harrison and R. Harcourt, of the Ontario Agricultural College, should give their services as a nucleus, the Association to provide accommodation, time, and students.

"The school, it might be stated, was in a measure a feeler thrown out to see to what extent the advantage of technical education might be appreciated by the bakers of this country. It is safe to say that there is no doubt as to the feeling in this direction, and efforts will be made to establish a permanent baking plant at the Ontario Agricultural College, where practical tests and experiments may be conducted, and courses in baking held in the near future.

"Professors Harcourt and Harrison are now in a position to know what the bakers require along the line of technical instruction. Previously they have been, figuratively speaking, groping in the dark. The study of flour has not been carried on to any great extent, and there are, therefore, no precedents for guidance in this study. Hitherto the difficulties of bakers have not been realized or apprciated except by themselves; but with the continued application of those so actively engaged in what has already been done, bakers will be in a position to obtain practical, as well as theoretical, help that will be of incalculable value to them."

The above extract shows that the Ontario bakers appreciate not only practical instruction, but also such experimental work as has been done for them by our Chemical and Bacteriological Departments. I trust that this work will be enlarged, and that facilities may be provided, not only for practical tests in baking, but also for laboratory work upon flours from Ontario, Manitoba, and elsewhere. One of our fourth-year students is at present working upon the acid bacteria which are found in flours; and I regret to say that this work has been considerably hindered during the session for lack of room. It seems hardly necessary to add that this is an additional reason for the erection and equipment of a new bacteriological laboratory.

The Duration of Life of the Tubercle Bacillus in Cheese.

Pathogenic germs, as a rule, have but slight vitality in cheese, but of those which may be present, the tubercle bacillus seems to be the most resistant. The large percentage of tuberculous dairy cattle in Europe, and even in newer countries, makes it important to inquire as to the length of life of the tubercle bacillus in cheese; how often and in what numbers it may be present; what danger there is to the individual who may eat cheese containing the germ; and whether the by-products from the manufacture of such cheese are dangerous to animals fed upon them.

Previous Investigations in the Same Field.

If we accept the conclusions of Rabinowitch and Klemperer, (1*) we must be prepared to acknowledge that, not only the milk of cows having either tubercle in the udder of advanced generalized tuberculosis is dangerous, but also the milk of cows which exhibit no clinical symptoms of the disease, but give the tuberculin reaction. If these results are accepted, a considerable increase must be recognized in the per-

* For bibliographic references, see page 112.

centage of tuberculous cattle whose milk will be regarded ar dangerous or treated as suspicious.

Galtier, (2) in 1887, examined cheese and whey, to ascertain what risk of contracting tuberculosis man and animals ran from eating these products. The experiments were made with normal milk tuberculosed by the addition of morbid material taken from diseased phthisical cows killed in the abattoirs, or from rabbits which have died from tuberculosis induced by injection. The milk was coagulated by the addition of rennet; and with the cheese and whey thus obtained attempts were made to ascertain the facts as to the transmission of tuberculosis. Unfortunately, Galtier does not state whether the curd was pressed and made into hard cheese or was left without pressure as soft cheese. The inoculations were made into guinea pigs (intraperitoneally) and into rabbits (intravenously). The particles of cheese were triturated in sterilized water, and the liquid part of the mixture, separated by decantation of filtration, was used for the inoculations. The whey was also filtered before each inoculation, and in this manner the animals were inoculated with cheese and whey of the age of 5, 10, 15, 20, and 30 days, etc. Some of the attempts did not furnish positive results; but the number of cases of undeniable transmission was large enough to establish the preservation of tubercle germs and of the noxious character of the products of the milk which contained them. Galtier obtained "generalized tuberculosis" from cheese not salted and salted, 5, 10, and 15 days old, and from some which was even 2 months and 10 days old. In several experiments, the disease was found in only one-half or one-third of the subjects inoculated; and in other experiments, which were not the most numerous, the results were negative in animals inoculated with cheese 2 months old and even only 15 days old.

The whey, separated from cheese 5, 10, and 15 days before, agitated and filtered before inoculation, invariably gave tuberculosis to guinea pigs, which, however, resisted the inoculation of this product made in doses of 2 c. c.

Like results were obtained from rabbits. Whey 2 days old produced innumerable tubercle lesions in the rabbits inoculated; and the same product, kept for 9 and 16 days, equally produced the disease, but in a slower and milder form.

Finally, cheese 5, 9, 16, and 20 days old, produced authentic tuberculosis in rabbits, from which the germ was subsequently cultivated on artificial media and transmitted to other animals.

From these experiments Galtier concludes that coagulated milk, fresh cheese and salted cheese, made from the milk of tuberculous cows, may infect man; that the by-products from such milk fed to swine and farmyard fowls may infect these animals; and that it is not irrational to conclude that a certain number of the cases of chicken and swine tuberculosis are due to this cause.

Heim (3) in 1889 also gave attention to this subject. He used cultures of tubercle bacilli grown upon sheep's blood serum. In curd which was mixed with tubercule bacilli he found living germs on the second day (using guinea pigs, injected intraperitoneally) with water-suspended particles of the curd, but none after 14 days.

In curd prepared from milk to which tubercle bacilli had been added, germs were found, even after 14 days, but none after 4 weeks; and also in the whey obtained at the same time, the bacilli were found alive after 14 days.

As may be noted, these results of Galtier's and Heim's differ considerably, the difference being accounted for in part by the different methods of experiment; and for this reason, as well as others, it seemed advisable to make some further investigation as to the duration of the life of the tubercle bacillus in cheese.

Description of Methods Employed in Switzerland.

While studying at Berne, I planned and conducted a series of experiments, as follows:

Cultures used. The growth from five potato-tube cultures, 4 weeks old, was scraped off and triturated in a sterile mortar with 6 per cent. glycerine. To this mass

was added the surface growth of tubercle bacilli from 125 c. c. of glycerine bouillon. The whole quantity was ground up as finely as possible and sterilized water (about 200 c. c.) added.

Manufacture of the Cheese. Two cheeses were made in separate vessels and by somewhat different methods, 10 liters, or about 22 pounds, of milk having been used for each. It was intended that these cheeses should, respectively, resemble as nearly as possible the Swiss Emmenthal and the American Cheddar varieties. Both lots of milk were heated to 35 degrees C. (95. F.), a portion of the tuberculous emulsion was added to each, and the mixture was thoroughly stirred. One-fifth of one of Hansen's rennet tablets, dissolved in water, was used for each cheese. Five minutes after the addition of the rennet, more of the tubercle emulsion was added, and again after fifteen minutes. The same amount was used in each cheese.

The milk had completely set in thirty-three minutes, and the curd was then cut and stirred with a wire stirrer and left for ten minutes. At the expiration of this time, cheese "A" was heated to 55 degrees to 56 degrees C., and kept constantly stirred for thirty minutes at this temperature, according to the usual practice in making Emmenthaler cheese. At the end of this time the curd was transferred to a suitable mould, and a 5-kilogram weight (11 pounds) placed upon it. Cheese "B" was stirred for two hours at a temperature of 36 degrees to 38 degrees C. (97 degrees to 100 degrees F.); this was in accordance with the Cheddar cheese method, in which the temperature does not rise above 37 degrees C. (or above 98 degrees F.). On account of lack of the necessary apparatus, other processes usual in making Cheddar cheese were not followed. The curd of this cheese (B) was also transferred to a mould and a 5-kilogram weight placed upon it. After four hours the weight was increased to 8 kilograms (17 1-2 pounds) on each cheese. The following day the cheese was turned, an operation which was twice repeated. On the second day they were removed from the moulds, and salt was rubbed all over them, a thin layer being left on the top. The cheese were kept at a temperature of about 5 degrees C. (41 degrees F.) for a week, being rubbed with salt and turned every day; and at the end of about 10 days they were removed to an empty chest in which the temperature was between 12 degrees and 18 degrees C. (53 degrees to 65 degrees F.). The cheese were kept free from mold by washing them every second or third day with strong brine for four weeks, after which they were washed only once a week.

Amount of cheese used for injection. A plug of cheese was removed with a sterile cork borer, and a varying quantity, drawn from the centre of the cheese, was transferred to a sterile mortar. This portion was thoroughly triturated with sterile distilled water of bouillon, and the remainder of the plug was replaced in the cheese.

Injections. Guinea pigs were used as the test animals, and the injections were made subcutaneously near the inguinal region. The first inoculation was very difficult, as the needle of the syringe, although large, became blocked by particles of curd. For subsequent injections the following technique was used, which gave good satisfaction: The animal was fastened to a dissecting board, and the hair was closely clipped over the inner portion of the thigh. This part was then washed with corrosive sublimate, after which a small hole was made in the skin with a large needle, and the end of a glass pipette (freshly made for each inoculation and consequently sterile) filled with the emulsion was introduced and the contents blown in. A pair of pressure forceps immediately applied to the small hole and held for a few minutes, closed the orifice and prevented the escape of the emulsion.

Th average weight of the guinea pigs used in the experiment was 500 grams, or about 18 ounces.

Observations of the animals during life. The animals were weighed and examined every week; and the presence of tuberculosis was often indicated by the swelling of the inguinal glands and by a gradual loss of weight. At the end of six weeks or longer, .1 c. c. of tuberculin was injected, and in animals badly affected death usually

followed in twenty-four hours ; but in animals slightly diseased there was a marked rise of temperature, often more than 2 degrees C. In fact, the smaller the amount of tubercle present, the more intense was the reaction. The same dose of tuberculin was often injected into healthy animals ; but in no case did the temperature rise 0.4 degrees C. above the normal.

Post Mortem. The post mortem examinations were made shortly after death, and animals not killed by the tuberculin injection were chloroformed and promptly examined. The presence of all lesions was noted. At least three preparations were made from diseased glands and organs, and these were stained by the Ziel Neelsen method.

If we examine Tables I. and II. we notice, almost at the first inspection, the difference in the vitality of the germs of tuberculosis taken from the different cheese. For instance, in the case of guinea pigs inoculated with Emmnethaler cheese 14 days old, the tuberculin reaction was high, the animals did not succumb to the injection, and the post mortem revealed less disease than was present in animals injected with Cheddar cheese 40 days old ; and, compared directly with the animals injected with the latter cheese of the same age, namely, 14 days, the difference was still more marked, one guinea pig dying naturally of the disease, and the other dying from the inoculation with tuberculin. Like results may be noticed from all the succeeding inoculations.

Observations upon the Results.

The tubercle bacilli in Emmenthaler cheese were all dead when the cheese was between 33 and 40 days old, for we find that the animals injected with 33-days-old cheese, although they gave a tuberculin reaction of 2 degrees C. and over, showed no signs of the disease at the post mortem, and both had gained considerably in weight. Cases similar to this have been noticed in tuberculin-tested cattle. Probably, if the inguinal glands from these animals had been transferred to other guinea pigs, the disease might have established itself in the reinjected animals. The animals subsequently injected (40 days, 47 days, etc.) were all free from tubercle and gave no marked tuberculin reaction. Two animals, however, died from other causes.

The tubercle bacilli in the infected Cheddar cheese were more long-lived, as they continued capable of causing disease up to 104 days old, at which time one guinea pig had a very slight infection, and the other was quite free from tubercle. By a mistake the guinea pigs infected from cheese 111 and 113 days old, respectively, were killed for other work about a month after injection. They were all perfectly healthy ; but as they had not been tested for tuberculin, and as sufficient time had not been given for tubercle bacilli to establish themselves, they are not included in Table II. One may, however, safely conclude that the vitality of tubercle bacilli in this cheese did not much, if any, exceed 104 days.

The great difference in the duration of life of the germs in the two cheese—about 70 days—can be ascribed only to the difference in the method of manufacture. The heat used in making the Emmanthaler cheese (from 50 degrees to 54 degrees C.) and the length of time the curds are kept at this temperature evidently causes the death of the weaker tubercle bacilli and the enfeeblement of the more resistant. The whey from this cheese was also less virulent. Guinea pigs inoculated with it did not die after the tuberculin inoculation, and the post mortem showed less disease than in those animals inoculated with the same quantity of whey from the Cheddar cheese.

The guinea pigs inoculated with cheese (both kinds) 7 days old, all died two days after inoculation ; and from these animals the bacillus of malignant edema, as well as Bacillus coli and B. staphylo-albus, were isolated. I cannot believe that the presence of these germs was due to an accidental infection, as exceptional precautions were taken to avoid such complications. At the same time, it is remarkable that subsequent inoculations did not show the presence of the bacillus of malignant edema, which, on account of the resistant nature of its spores, one would expect to survive in

Results of inoculating guinea pigs with cheese and whey of various ages, to test infection of tubercle bacilli.

EXHIBIT I.—EMMENTHALER CHEESE.

No. of guinea pig	Age of inoculated cheese.	Quantity of cheese inoculated	Tuberculin reaction.	Died or killed, and days after inoculation.	Post mortem.	Microscopic examination.	Remarks.
		Grams.	° *C.*				
1	Fresh curd	½	1.7	Died, 52 days..	Tubercle in inguinal and retro-peritoneal glands, mesentery, spleen, and liver.	Tubercle bacilli in the glands and spleen.	Died 24 hours after injection of 0.1 c. c. tuberculin.
2	7 days.....	½	.....	Died, 2 days ..	Muscles dark and infiltrated, edematous fluid.	Bacilli and staphylococci in the fluid.	Cultures and inoculation of rabbits showed *B. coli*, *B. edematis maligni*, and *Staphylococcus albus*.
3	do	½	....	do ..	do	do	do.
4	14 days..... ..	½	2 0	Killed, 56 days	Tubercle in inguinal and retro-peritoneal glands, liver, and spleen.	Tubercle bacilli in glands and spleen.	Inoculated with 0. 1 c. c. tuberculin.
5	do	½	2.2	do ..	do	do	do.
6	21 days.....	½	2.0	Killed, 49 days.	Tubercle in inguinal and retro-peritoneal glands ; spleen, slightly affected.	Tubercle bacilli in the glands.	do.
7	do	½	1.9	do ..	Tubercle in inguinal, retroperitoneal, and mesenteric glands ; spleen slightly affected.	do	do.
8	28 days.....	¾	1.9	Killed, 59 days.	Tubercle in inguinal and retro-peritoneal glands.	do	do.
9	do	¾	1.4	do ..	do	.....	
10	33 days.....	¾	2.0	Killed, 64 days.	All organs normal ; animal in good health ; has gained 160 grams since inoculation.	No tubercle bacilli found in either the glands or organs.	Inoculated with 0. 1 c. c. tuberculin. A control animal injected with the same quantity of tuberculin gave a reaction of 0.2° C.
11	do	¾	2.3	do ..	All organs healthy ; has gained 230 grams since inoculation.	do	do.
12	40 days.....	¾	0.3	Killed, 70 days	All organs and glands normal	No tubercle bacilli	Inoculated with 0.1 c. c. tuberculin.
13	do	¾	0.4	do .	do	do	do.
14	47 days...	1	0.2	Killed, 64 days.	do	do	
15	do	1	0.4	do ..	do	do	do.
16	54 days.....	1	0.5	Killed, 66 days.	do	do	do.
17	do	1	0.3	do ..	do	do	do.
18	63 days.....	1	0.3	Killed, 58 days.	do	do	do.
19	do	1	....	Died, 7 days ..	do	do	
20	70 days.....	1	.....	Died, 46 days..	Intestine strangulated through a hole in the mesentery.	do	
21	do	1	0.4	Killed, 65 days.	All organs and glands normal	do	do.

EXHIBIT II.—CHEDDAR CHEESE.

1	Fresh curd	½	1.2	Died, 45 days	Inguinal, mesenteric, and retroperitoneal glands tuberculous. Tubercle in the spleen.	Tubercle bacilli in all glands	Died, 36 hours after injection of 0.05 c. c. tuberculin.
2	7 days	1		Died, 2 days	Muscles dark and infiltrated; edematous fluid.	Large bacillus and staphylococci in the fluid.	Cultures and inoculation of rabbits showed *B. coli*, *B. edemantis maligni*, and *Staphylococcus albus*.
3	do	1		do	do	do	do.
4	14 days	½		Died, 35 days	Inguinal, retroperitoneal and mesenteric glands infected; also spleen and liver.	Tubercle bacilli in glands and spleen.	
5	do	½	1.6	Died, 49 days	do	do	Died 24 hours after injection of 0.1 c. c. tuberculin.
6	21 days	½	1.1	Killed, 49 days.	Tubercle in inguinal and retroperitoneal glands, spleen and liver.	do	
7	do	½	1.0	Died, 50 days	do	do	do.
8	28 days	¾		Died, 56 days	Tubercle in inguinal and retroperitoneal axillary glands, spleen, liver, and lungs.	Tubercle bacilli in glands and liver.	Died 1 hour after injection of 0.1 c. c. tuberculin; was very weak and sick before injection.
9	do	¾	0.9	Killed, 57 days.	Tubercle in glands, spleen, liver, and lungs. Tubercles on the peritoneum.	Tubercle bacilli in glands and spleen.	
10	33 days	¾	1.2	Died, 64 days	Tubercle in glands, spleen, and liver.	Tubercle bacilli in glands	Died 24 hours after injection of 0.1 c. c. tuberculin.
11	do	¾		Died, 10 days	Peritonitis	No tubercle bacilli in glands	
12	40 days	¾		Died, 7 days	Very much wasted; large swelling at seat of inoculation.	Cultures from the spleen and microscopic examination showed staphylococcus albus.	do.
13	40 days	¾	0.9	Died, 70 days	Tubercle in inguinal and retroperitoneal glands, and in spleen, liver and lungs.	Tubercle bacilli in glands and liver.	
14	47 days	1	0.9	Died, 64 days	Tubercle in inguinal and retroperitoneal glands, spleen, and liver.	do	Died 24 hours after injection of 0.1 c. c. tuberculin.
15	do	1	0.5	do	do	do	do
16	54 days	1		Died, 5 days	Peritonitis		
17	do	1		Died, 64 days	Tubercle in inguinal and retroperitoneal glands, spleen, and liver.	Tubercle bacilli in glands and spleen.	
18	63 days	1	1.1	Died, 57 days	do	Tubercle bacilli in glands and liver.	do
19	do	1	0.8	do	do	do	
20	70 days	1	0.8	Died, 65 days	do	Tubercle bacilli in glands	do
21	do	1	0.5	do	do	do	do
22	77 days	1	0.9	do	Tubercle in inguinal and retroperitoneal glands and spleen.	do	do

Results of inoculating guinea pigs with cheese and whey of various ages, to test infection of tubercle bacilli.—*Continued.*

EXHIBIT II.—CHEDDAR CHEESE.—*Continued.*

No. of guinea pig.	Age of inoculated cheese.	Quantity of cheese inoculated	Tuberculin reaction.	Died or killed, and days after inoculation.	Post mortem.	Microscopic examination.	Remarks.
		Grams.	° *C.*				
23	77 days.....	1	1.0	Died, 65 days..	Tubercle in inguinal and retro-peritoneal glands and spleen.	Tubercle bacilli in glands.	Died 24 hours after injection of 0.1 c. c. tuberculin.
24	84 days.....	1	1.3	Killed, 40 days.	Tubercle in inguinal and retro-peritoneal glands.	do	0.1 c. c. tuberculin inoculated.
25	do	1	1.5	do ..	do	do	do
26	104 days.....	1	2.0	Killed, 70 days.	Tuberculosis in inguinal glands...	do	do
27	do	1	0.3	do ..	All organs and glands normal; much increase in weight.	No tubercle bacilli.....	do
28	125 days.....	1	0.4	do ..	All organs and glands healthy....	do	do
29	do	1	0.2	do ..	do	do	do
30	132 days.....	1½	0.2	do ..	do	do	do
31	do	1½	0.5	Killed, 71 days.	do	do	do

EXHIBIT III.—WHEY.

	Age and kind of whey.	c. c.					
1	Whey from cheese A, 4 hours old.	1.5	1.5	Killed, 70 days.	Tubercle in inguinal and retro-peritoneal glands, spleen, and liver.	Tubercle bacilli in glands and spleen.	0.05 c. c. tuberculin inoculated.
2	Whey from cheese A, 48 hours old.	1.5	1.4	Killed, 49 days.	Tubercle in inguinal and retro-peritoneal glands and spleen.	Tubercle bacilli in glands.....	0.1 c. c. tuberculin inoculated.
3	do	1.5	1.7	do ..	do	do	
4	Whey from cheese B, 4 hours old.	1.5	1.6	Died, 43 days..	Tubercle in inguinal and retro-peritoneal glands, spleen, and liver; badly infected.	Tubercle bacilli in glands and liver.	0.05 c. c. tuberculin injected; died 24 hours later.
5	Whey from cheese B, 48 hours old.	1.5	1.1	Died, 49 days..	Tubercle in inguinal and retro-peritoneal glands, spleen, and liver.	do	0.1 c. c. tuberculin inoculated; died 36 hours later.
6	do	1.5	1.4	do ..	do	do	

Exhibit IV.—Cream Cheese

	Kind of cheese.	*Grams.*					
1	Cream cheese..	2	1.2	Died, 57 days..	Tubercle in inguinal and retro-peritoneal glands, spleen and liver.	Tubercle bacilli in glands and spleen.	0.1 c. c. tuberculin injected; died 36 hours later.
2	do ..	2	....	Died, 4 days...	do	do	do
3	do ..	2	0.3	Killed, 58 days.	All organs and glands normal.	No tubercle bacilli.....	0.1 c. c. tuberculin injected.
4	do ..	2	0.4	do ..	do	do	
5	do ..	2	0.2	do ..	do	do	do
6	do ..	2	0 2	do ..	do	do	do
7	do ..	2	1.3	do ..	Tubercle in inguinal and retro-peritoneal glands and spleen.	Tubercle bacilli in glands..	do
8	do ..	2	1 2	Killed, 49 days	do	.....	
9	do ..	2	2.1	Killed, 50 days.	Tubercle in inguinal and retro-peritoneal glands.	Tubercle bacilli in glands.....	do
10	do ..	2	2.5	do ..	do	do	

Exhibit V.—Cheddar Cheese made in Canada.

1	Fresh curd	1	1.9	Died, 70 days.	Tuberculosis of inguinal, retroperitoneal glands, spleen and liver.	Tubercle bacilli in glands	Died 18 hours after injection of 0 1 c.c. tuberculin.
2	do ...	1	1.4	do ..	do	do	do
3	7 days	1.5	....	Died, 6 days...	Peritonitis	Coli infection.....	
4	do	1.5	1.5	Died, 78 days..	Tuberculosis of glands, spleen and liver; the latter badly infected.	Tubercle bacilli in glands	Died 24 hours after injection of tuberculin.
5	14 days.....	1.5	1.5	Died, 90 days..	Tuberculosis of inguinal retroperi toneal, and mesenteric glands; spleen and liver badly infected.	Tubercle bacilli in liver and retro-peritoneal glands.	
6	do	1.5	2.2	Died, 84 days..	do	do	Died 18 hours after injection of 0.1 c.c. tuberculin.
7	21 days..... ..	1.5	.....	Died, 42 days..	Tuberculosis of inguinal, retroperitoneal, and mesenteric glands, spleen and liver.	Tubercle bacilli in liver.....	
8	do	1.5	1.4	Died, 63 days..	do	Tubercle bacilli in liver and retro-peritoneal glands.	Died 28 hours after injection of 0.1 c.c. tuberculin,
9	28 days... . ..	1.5	.....	Died, 2 days...	Peritonitis; edema	Coli bacteria and a bacillus resembling *B. edematis maligni.*	
10	do	1.5	1.7	Died, 63 days..	Tuberculosis of glands, liver and spleen.	Tubercle bacilli in liver	do
11	37 days.....	2	1.9	Killed, 65 days.	Tuberculosis of inguinal and retro-peritoneal glands and spleen.	Tubercle bacilli in glands	0.1 c.c. tuberculin injected.
12	do	2	1.6	do ..	do	do	do
13	42 days.....	2	1.6	Killed, 56 days.	do	Tubercle bacilli in retroperitoneal glands.	do

Results of inoculating guinea pigs with cheese and whey of various ages, to test infection of tubercle baccilli.—*Concluded.*

EXHIBIT V.—CHEDDAR CHEESE MADE IN CANADA.—*Concluded.*

No. of guinea pig.	Age of inoculated cheese	Quantity of cheese inoculated	Tuberculin reaction.	Died or killed, and days after inoculation.	Post mortem.	Microscopic examination.	Remarks.
		Grams.	° *C.*				
14	42 days	2		Died, 12 days	Streptococcus infection	Streptococci in organs and blood.	
15	52 days	2	1.8	Killed, 63 days.	Tuberculosis of inguinal and retroperitoneal glands; spleen slightly infected.	Tubercle bacilli in retroperitoneal glands.	0.1 c.c. tuberculin injected.
16	do	2	1.7	do	do	do	do
17	62 days	2	1.7	Killed, 67 days.	Tuberculosis of inguinal and retroperitoneal glands.	Tubercle bacilli in glands	do
18	do	2	1.5	do	Tuberculosis of inguinal glands	No tubercle bacilli	do
19	70 days	2	.6	Killed, 70 days.	All organs and glands normal and healthy.	do	do
20	do	2	.4	do	do	do	do
21	80 days	2	.4	Killed, 64 days.	do	do	do
22	do	2	.3	do	do	do	do
23	91 days	2	.4	do	do	do	do
24	do	2	.6	do	do	do	do
25	102 days	2	.4	Killed, 62 days.	do	do	do
26	do		.4	do	do	do	do
27	112 days		.6	Killed, 82 days.	do	do	do

the cheese for some time. Weigmann has found and cultivated from cheese bacilli similar in morphological character.

The tuberculin reactions which served incidentally for measuring the strength of the tuberculin used have been already mentioned, and the results obtained fully confirmed those given by Donitz. They also served, apart from the post mortem, to give some idea of the extent of the disease in the guinea pigs, the amount of the disease usually being in inverse ratio to the amount of the reaction. Reference and comparison of Tables I. and II. show this very strikingly.

Conclusions from the Original Experiments in Switzerland.

From these results we are safe in concluding that hard cheese—especially Emmenthaler—is quite safe for human food so far as tuberculosis is concerned. Both Cheddar and Emmenthaler are seldom eaten until they are 4 months old or more; at this stage all tubercle bacilli which they may have contained will be dead. We should also remember that the number of tubercle bacilli likely to be present in cheese, as commonly made, is very small, and that in all probability those will die sooner than bacilli put into cheese in the course of experiments like these. Besides this, the original number of such germs in milk will be reduced by being carried off in the whey.

From the experimental data it would seem advisable to use the milk of tuberculous cows, segregated according to Bang's system, for making cheese rather than butter—that is, on the assumption that the latter is made without proper pasteurization of milk or cream. The whey from such milk should be heated to 85 degrees C. (185 degrees F.), which would not only kill any tubercle bacilli that might be present, but would also have other excellent economic effects.

Experiments With Whey, and Comments.

The experiments with the whey from cheese A and B were ony to find out if the tubercule bacilli in milk were present in numbers in the whey and if they could live therein for 48 hours, as this is about the limit of time that whey is kept. As has already been remarked, the whey from the Cheddar cheese (B) was more virulent than that from the Emmenthaler (A); but the latter was also infectious. Ostertag 4 has noted that intestinal tuberculosis is sometimes caused by feeding separator slime to pigs; Galtier also remarked on the probability of swine and poultry becoming infected with tubercle by eating the by-products of milk; and, in my opinion, this phase of the question is even more important than the human side. At present, outside of Denmark, very little whey is pasteurized, or rather heated to 85. degrees C.; and when we consider the small cost of the operation (as exhaust steam may be used for the purpose) and the benefits to be derived from it, we wonder why it is not done more frequently. In America cheesemakers look upon the contamination of milk cans by unpasteurized whey as one of the principal sources of the many troubles met with in making cheese during the summer months. So we have a threefold benefit from heating whey to 85 degrees C.: (1) Destruction of tubercle and other pathogenic bacteria; (2) better keeping of the whey itself; (3) the removal of a prolific source of bacterial contamination of milk cans.

Denmark, 5 recognizing the danger in the by-products of milk, has enacted a law which makes compulsory the heating of all such products (whey, skim milk, and buttermilk) to at least 85 degrees C. (185 degrees F.).

Trials With Cream Cheese, and Results.

As will be noticed in the tables, a few trials were also made with cream cheese. The samples of this variety were bought on the open market in Berne, and the age of some of them was not known; but they all appeared to be only a few days old. Too few

samples were examined to warrant the drawing of general conclusions from the experiments. The amount of cheese injected was rather large ; and we must remember that a larger proportion of tubercle bacilli is found in cream and in milk sediment than in the milk. Even in the separator, many bacilli are thrown out with the cream. So we may expect that a larger number will be found in cream cheese than in ordinary hard cheese. Of the five samples examined three were found to contain tubercle bacilli—one cheese evidently containing large numbers, if we can judge from the amount of infection. See guinea pig No. 1, Table IV.). The others were only slightly infected.

There is evidently, then, some danger to be apprehended from cheese of this kind —just how much cannot be stated. But there is no reason why pasteurized cream should not be used for cream cheese, because the objections to using pasteurized milk for making hard cheese do not hold in making cream cheese.

Note.—The work described herein was done in the bacterological institute of the University of Berne, and I wish to record my sincere thanks to Dr. de Freudenreich for his kind assistance, interest, and criticism while the work was in progress.—F. C. H.

Supplementary Report Based Upon Cheddar Cheese.

The experiments upon the duration of life of the tubercle bacillus in cheese made at Berne in 1899-1900 (published in the Landwirtschaftlichen Jahrbuch der Schweiz, 1900, and of which the foregoing is a translation), demonstrated that the tubercle bacillus died between the thirty-third and fortieth days in cheese made after the Emmenthaler method ; but in cheese made approximately after the Cheddar method, the duration of life of the bacillus was considerably longer.

On account of objections to the imperfect method of manufacture of the Cheddar-like cheese made in Berne, it seemed advisable to repeat the experiment by making a typical Cheddar cheese in a country where such cheese is regularly made. As Russell remarks (Outlines of Dairy Bacteriology) :

" Our domestic Swiss cheese, or even cheese of this class made in Germany, rarely have the peculiar flavor that is found in the product imported from the Swiss valleys. For centuries this brand of cheese has been made in that country, until the factories and dairies have become stocked with the right kind of germs, capable of producing the desired fermentation."

If this is true of Swiss cheese manufactured in America, it is likely to be also true of Cheddar cheese made in Switzerland. If added to this objection there is the further one that the details of manufacture of Cheddar cheese made in Switzerland were not identical with the ordinary practice in the making of this cheese, we clearly see that in the interest of scientific accuracy, as well as in the comfort and security that might be obtained from the knowledge of the fact that any tubercle bacilli were likely to be dead before the cheese was ripe and ready to be eaten, it was necessary to carry out another series of experiments upon Cheddar cheese made in the approved manner. This was accordingly done by the writer in the year 1901, and these experiments are first described and reported as follows :

Culture.

The culture used was of bovine origin, the seventh transfer since isolation from a tuberculous guinea pig inoculated with a piece of liver from a tuberculous cow. The whole of the growth from 700 c. c. of glycerine bouillon 12 weeks old was used. The growth was very heavy, and on account of the difficulty of separating the masses of bacilli in the pellicle, sterilized powdered glass was used in order to break up the clumps of bacilli, and a fairly good emulsion was thus obtained, which was added to the milk at the same time as the rennet. The infected milk was then stirred constantly for five minutes, when coagulation commenced.

The Cheese.

Eighty pounds of milk in good condition were used for making the cheese. The acidity of the milk was 0.14 per cent., and 1½ pounds of a pure culture of a lactic acid bacillus was added, together with 1 dram of cheese color. The milk was set at 36 degrees F., after the rennet test was found to be twenty seconds. Two drams of rennet were used. The other particulars about making this cheese were as follows :

Time between setting and dipping	3 hours.
Time between dipping and milling	2 hours 10 minutes.
Time between milling and salting	1 hour 10 minutes.
Amount of acid at milling	1½ inches.
Amount of salt	3 ounces.
Acidity of curd before salting	8 per cent.
Weight of press on cheese	1,000 pounds.
Weight after cheese was turned	2,000 pounds.

The cheese worked quite normally, the curd having a nice silky feeling and meaty texture. All operations of stirring, etc., were performed with the hands inclosed in a pair of rubber gloves, such as are employed for surgical use, the endeavor being to produce a typical Cheddar cheese, made in exactly the same manner as in a cheese factory.

The cheese was ripened at an average temperature of 60 degrees F., which is regarded as being very suitable for Cheddar cheese, as it does not injure the texture or cause the fat to run out.

With regard to such details as the amount of cheese used for inoculation of the guinea pigs, the method of inoculation, observations of animals during life, autopsy, and microscopic preparations, they were the same as in the Berne experiments ; hence it is unnecessary to repeat them.

The acidity of the cheese was tested when a month old. Five grams of cheese and an equal amount of glass were ground together in a mortar ; 100 c. c. of water was then added and well mixed with the cheese. After standing fifteen minutes, the mixture was passed through a filter paper. Twenty-five cubic centimeters of the clear filtrate were taken for the determination of the acidity. Phenolphtalein was used as an indicator. The result of this test showed 0.95 per cent. acid—figured as lactic acid. A bacteriological analysis was also made at the end of one month ; and 1 gram of cheese contained 43,700,000 lactic acid bacteria. No other species were present on the culture plates.

Reference to the table shows that the tubercle bacilli died out somewhere between the sixtieth and sixty-second days. Even previous to the sixty-second day, there was evidence to show that the number of living tubercle bacilli was small, or else their virulence was much weakened, for the guinea pigs inoculated on the forty-second and fifty-second days were all lightly infected.

Three animals were lost from other infection. The one which died after the inoculation of cheese 7 days old may have obtained the infection directly from the cheese, but the other two cases were probably due to other causes.

A comparison of the results obtained from this true Cheddar cheese with the results of the partly simulated Cheddar made at Berne show that considerable difference exists between the two ; in fact, a difference of thirty-four days in favor of the genuine Cheddar. There are several probable explanations of this difference. The greater acidity developed in the true Cheddar cheese, both during making and subsequent ripening, must have a certain effect on the tubercle bacilli; and the fact that the salt was directly mixed with the curd, instead of being rubbed on the cheese from the outside and then slowly penetrating inward, would also have some influence. The pressure on the properly made cheese was also much greater, and, although this would make no differ-

ence to the bacilli present in the cheese, a much closer texture resulted, and this may have had some effect. All three of these factors might together influence and curtail the duration of life of the tubercle bacilli in Cheddar cheese.

Conclusions Verified and Repeated.

These later experiments fully verified the conclusions first reached and justify this statement: If Cheddar cheese, as commonly made in the United States and Canada, happens to contain tubercle bacilli, naturally present, it may be assumed that none of these germs will be living when the cheese is ten weeks old; hence no danger need be apprehended of acquiring the disease known as consumption by eating well-cured Cheddar cheese.

Bibliographic References.

1. Rabinowitch and Klemperer. Zeitschrift fur Hygiene, 1899, vol. 31, p. 137.
2. Galtier. Comptes endus de l'Acadamie des Sciences T. 124, p. 1333.
3. Heim. Untersuchungen uber die Wert bestimmung des gewohnlichen Tuberkulins, Klinischen Jahrbuch, 1898.
4. Ostertag. Milch Zeitung, 22, p. 672.
5. Bang (Denmark). La Lutte contre la Tuberculose animale par la Prophylaxie. Noidiskt medicinskt Arkiv. 1899, No. 22.

Respectfully submitted,

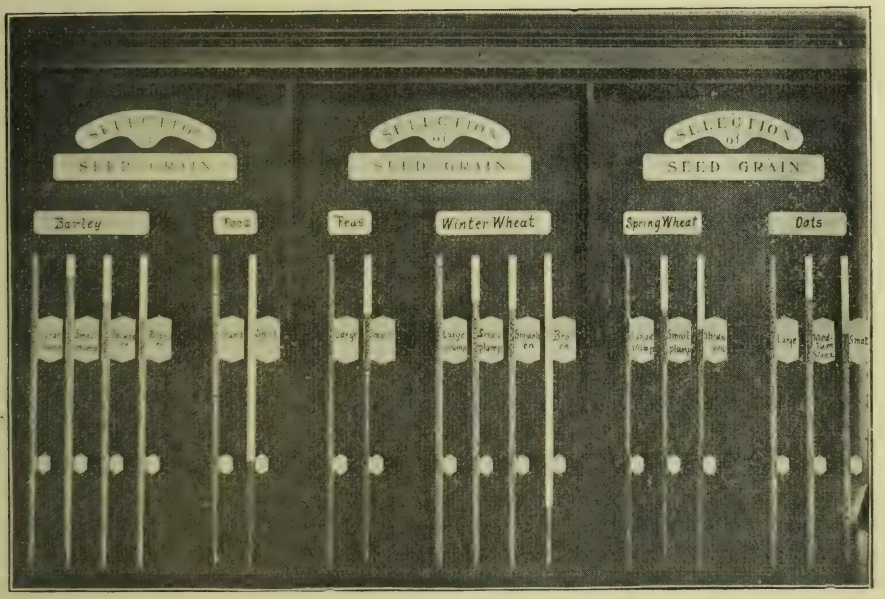
F. C. HARRISON,
Professor of Bacteriology.

PART XIII.

THE EXPERIMENTALIST.

To the President of the Ontario Agricultural College :

Sir,—I have the honor of submitting herewith my report of the work done in the Experimental Department during the year 1903. This is my eleventh annual report since I was placed at the head of the department, and the seventeenth since I first became connected with the College experimental work. During these seventeen years, the experimental plots at the College have been increased from fifty-four to two thousand, and the co-operative experimenters on the farms throughout Ontario from none to three thousand three hundred and forty-five.



View of case in Agricultural Museum, showing results of experiments in selection of seed grain. The yields per acre obtained from the different selections indicated by the labels, are shown by the comparative amounts of grain in the tubes. (See page 118).

Experiments in Field Agriculture or Agronomy.

The work of this department during the past year might be divided in the following manner :

1. The conducting of practical experiments in field agriculture on about 2,000 plots. These plots varied in size according to the requirements of the various experiments, but, in all cases, they were sufficiently large to enable us to ascertain the yields of the various crops under investigation. For the results of this work, the reader is referred to the report which follows.

2. The carrying on of scientific work, the results of which should have a practical as well as a scientific bearing. The subject of plant breeding has received a good deal

of attention. Since the discoveries of Mendel, as well as the investigations of Bateson, De Vries, and Correns, have been made known, this line of work can be followed with greater interest and more encouraging results.

3. The furnishing of plans, seeds, and instructions for illustration plots on the exhibition grounds at Whitby, Renfrew, Owen Sound, Walkerton, Brantford, and Simcoe.

4. The directing of co-operative experiments on 3,345 farms throughout the Province. The co-operative work leads to a substantial increase in farm profits, and also combines in an admirable way the training of the hands and the training of the intellect, and is one of the greatest educational features which have been introduced throughout the rural districts of Ontario in recent years.

5. The delivering of about one hundred lectures to College students and at agricultural conventions. Within the past year, the writer has delivered lectures to about 140 students in the regular College course, 55 students in the dairy course, and 250 students in the two short courses in stock and grain judging. The other lectures which have been delivered since last year are about as follows : Fifteen at meetings of Farmers' Institutes; 12 or 15 in the experimental grounds to the thousands of excursionists who visit the College in the month of June; 4 at Seed Fairs; 7 at the Model Fairs at Whitby, Walkerton, Brantford, and Simcoe; 3 at the Annual Meeting of the Ontario Agricultural and Experimental Union ; 1 at the Broadview Boys' Institute, Toronto; 2 at the agricultural conventions held at the Western Dairy School, Strathroy; 2 in school sections in connection with the proposed establishment of the first Consolidated Rural School in Ontario ; one on co-operative experimental work before the faculty and students in agriculture at Cornell University, Ithaca, N.Y.; 3 at the Annual Meeting of the Provincial Farmers' Association of New Brunswick; 3 at the Annual Meeting of the Provincial Farmers' Association of Nova Scotia; 1 at the Annual Meeting of the Provincial Fruit Growers' Association of Nova Scotia; and 3 at the Annual Meeting of the Fruit Growers' Association of Prince Edward Island.

6. The writing of reports and agricultural articles. (1) Report of the Experimental Department of the College; (2) Report of the co-operative experiments in agriculture in connection with the Ontario Agricultural and Experimental Union ; (3) Miscellaneous articles for agricultural journals, newspapers, etc.

7. The carrying on of a heavy agricutural correspondence. For several weeks in the spring, and again in the fall, the number of letters and cards received averaged more than one hundred daily. Some of these enquiries took much thought and care in answering. The amount of correspondence with Ontario farmers is increasing from year to year.

8. Judging at agricultural exhibitions. During the past year, the writer acted as judge on farm crops at the following agricultural fairs : The Dominion Exhibition, Toronto; the Model Fair, Whitby; the Agricultural Fair, Stratford; the Norfolk Union Fair, Simcoe; the Spring Seed Fair, Guelph; the Spring Seed Fair, Fergus; and the Fall Seed Fair, Guelph. The writer also judged the plots at the Broadview Boys' Institute, Toronto.

Experimental Work at the College.

The practical work in the Experimental Department consists in planning the various experiments ; laying out, seeding, and looking after the field plots; harvesting, threshing, weighing, and testing the grain; taking up, weighing, counting, testing, and storing the potatoes and roots; cutting, weighing, and harvesting the grass, corn, and fodder crops, etc,. and also in picking by hand the samples of grain grown on the plots, some to be sown on the plots the following year, and some to be distributed for co-operative experimental work throughout Ontario. But few people realize what a large amount of very careful thought is required in planning, supervising, and examining these plots, and in studying, comparing, and summarizing the results for presentation in reports, bulletins, newspaper articles, and lectures.

Experimental Grounds. About fifty acres of land, divided into about 2,000 plots, is used for agricultural field experiments, conducted with varieties of grain, root, tuber, grass, clover, fodder, silage, and miscellaneous crops; with artificial, green, and farmyard manures; with methods of cultivation, selection of seed, dates of seeding, etc.,—all with the greatest care, and for several years in succession—in order to secure strictly accurate and reliable results. These experiments deal with the crops grown on over nine-tenths of the cultivated land in Ontario,—that is, fully 10,000,000 acres.

Experimental Plots. The experimental grounds have a gentle slope towards the southwest, and the soil is what might be termed an average clay loam. Nearly one-quarter of the land is manured each year with twenty tons (about twelve loads) of farmyard manure per acre. It will thus be seen that the most of the land receives farmyard manure once every four years. No commercial fertilizers are used, except in distinct fertilizer experiments, which occupy from two to three acres each year, and on which tests are made to ascertain the comparative value of different fertilizers with different crops. The plots vary in size according to the requirements of the different experiments, and the yields per acre are determined from the actual yields of the plots in every instance.

Results of Experiments.

All our field experiments are conducted for at least five years before any of them are dropped. For the results of many of the tests which were carried on for five years previous to 1903, the reader is referred to former reports. The results of some of the experiments which have as yet been conducted for only one or two years are held back until the tests can be carried through at least another summer. As different seasons vary so much in temperature, amount of rainfall, etc., the average results of experiments continued for several years are of much greater value than those secured from only one year's work. We submit the results with much confidence in their reliability, and in their real, practical value. The writer has had good reason to believe that the work of the Experimental Department is being appreciated by the farmers of the Province, and that the results are being studied more and more each succeeding year. I shall limit my remarks on each separate experiment, the results of which are here presented, to a few of the points which seem to be of the greatest value to the agriculture of Ontario.

Weather Conditions During the Past Summer.

In order to study the reports intelligently, it is well for us to know a few points in reference to the weather conditions of the past summer. According to the Report of the Bureau of Industries, the mean temperature for March in 1903 was 37.4 degrees, while that for 1902 was 35 degrees, and that for the average of the last twenty-one years, 25.8 degrees. It will, therefore, be seen that the month of March in 1903 was exceptionally warm. Both April and May of the past season were also somewhat warmer than usual. In June, however, the temperature was about three degrees lower than is usual for that month. In July the temperature was about the same as in the average of the past twenty-one years.

According to the determinations made by the Department of Physics at the College, the rainfall was comparatively light in the early part of the season, but was about normal in May, June, and July.

The first seeding which took place in the experimental plots in 1903 was on the 2nd of April. Most of the grains were sown in April; the mangels, sugar beets, carrots, corn, sorghum, and part of the potatoes in May; and the turnips, rape, millet, beans, and part of the potatoes in June.

Farm Crops in Ontario,

We are indebted to the Reports of the Bureau of Industries for Ontario for the information that the market value of the farm crops grown in the Province in 1902

amounted to $146,421,171, and that the average market value of the farm crops produced in Ontario for the last twenty-one years has amounted to $112,846,470 per annum. This amount represents the combined values of wheat, barley, oats, peas, beans, rye, buckwheat, corn, potatoes, carrots, mangels, turnips, hay, and clover. It is the object of the Experimental Department to conduct such experiments with farm crops, the results of which are likely to exert an influence in increasing both the quantity and the quality of the products of the farms throughout Ontario. Anything which could be done to increase the market value of Ontario's crops one per cent. per annum would add over $1,000,000 increase each year, or sufficient to maintain more than one dozen agricultural colleges similar to the one located at Guelph.

The figures in the table here presented furnish information regarding the principal farm crops grown in Ontario in 1903; the varieties grown in the experimental grounds at the Agicultural College within the past seventeen years; and the number of varieties of each class of crop used in connection with the co-operative experiments throughout Ontario in the past year :

Farm crops.	Acres of each crop in Ontario in 1903.	Number of varieties tested.	
		At O.A.C. within 17 years.	Over Ontario in 1903.
Hay and clover	2,783,565	76	11
Oats	2,645,965	265	3
Barley	709,839	114	5
Winter wheat	666,595	182	3
Corn	588,651	254	9
Peas	407,133	104	4
Spring wheat	252,855	150	3
Rye	179,277	9	
Potatoes	138,011	278	5
Turnips	134,717	191	5
Buckwheat	95,487	6	2
Mangels	80,918	113	3
Beans	53,973	41	3
Carrots	7,805	64	2

Besides the crops named in the table, the Experimental Department has also been carrying on careful tests with Emmer, Spelt, Sugar Beets, Parsnips, Kohl Rabi, Sorghum, Sunflowers, Rape, Tares, Artichokes, Flax, Pumpkins, Squashes, Pasture Grasses, etc.

In comparing the areas devoted to the various farm crops throughout Ontario within the past five years, we find the greatest increases to be in mangels (69 per cent.) and barley (62 per cent.) We also find that the greatest decreases during the same period were peas (53 per cent.), Buckwheat (37 per cent.), Carrots (37 per cent.), Winter Wheat (36 per cent.), and Spring Wheat (35 per cent.)

A Comparative Test of Different Classes of Grain.

Much has been done in an experimental way in testing different varieties of nearly all classes of farm crops. But very little, however, has been done to ascertain the comparative yields of leading varieties of the different classes of farm crops under similar conditions. An experiment was conducted at the College in 1902, and again in 1903, in order to obtain some definite information regarding the comparative yields of different classes of farm crops when grown and handled under as nearly uniform conditions as possible. The seeding took place on April 24th in 1902, and on May 5th in 1903, and the experiment was conducted in duplicate each year. The figures here presented give the average results, therefore, of four separate experiments in growing farm crops under similar conditions within the past two years :

Comparative Results of Different Classes of Grain.

Class of crops.	Variety.	Average results for two years—four tests.				
		Date of Ripening.	Height.	Per cent. Rust.	Yield per Acre.	
					Straw.	Grain.
		August.	Inches.		Tons.	Pounds.
Oats	Joanette	12	37	7	2 8	2,693
Barley	Mandscheuri	6	38	11	1.8	2,611
Emmer	Common	22	39	6	2.1	2,556
Hulless barley	Black	5	30	16	1.8	2,298
Early Oats	Alaska	4	41	11	1.9	2,249
Hulless barley	White	8	32	5	1.7	1,995
Spring wheat	Wild Goose	29	45	15	2.2	1,615
Spring rye	Common	17	50	5	2.1	1,423
		Sept.				
Vetches	Spring	6	36	.....	2.0	759

From the results here presented, it will be seen that the Joanette oats gave the largest weight of grain per acre, while the Alaska variety of oats occupied fifth place in this respect. The Mandscheuri barley came second, and Emmer third, in productiveness. Generally speaking, oats have about thirty per cent., and Emmer about twenty-five per cent. of hull. The two varieties used in this experiment, however, have considerably less hull than most varieties of oats. A more detailed description of Emmer is given further on in this report. Of the crops under experiment, the Alaska oats were the earliest, and the Common Vetches were the latest, to mature. The weakest straw was produced by the White Hulless barley and the Alaska oats, and the stiffest straw by the Wild Goose spring wheat. This experiment will likely be repeated for several years.

As some of the same varieties of crops were distributed throughout Ontario in the spring of 1902, and again in 1903, for co-operative experiments, a reference to the results obtained will be interesting for comparison with the results at the College. It should be understood that the crops grown throughout Ontario are the averages of a large number of tests made on separate farms. The average soil on which any one crop would be grown would, therefore, not be exactly the same as the average soil used for the experiments with other crops.

Class of crop.	Variety.	Average yield per acre.			
		Tons of straw 2 years.	Pounds of grain.		
			1902.	1903.	Average 2 years.
Emmer	Common	1.8	2,126	1,810	1,968
Barley	Mandscheuri	1 6	1,672	2,158	1,915
Oats	Siberian	1.7	1,737	1,853	1,796
Peas	Early Britain	1.5	1,166	1,955	1.561
Early Oats	Alaska	1.4	1,398	1,617	1,508
Hulless Barley	Black	1.5	1,536	1,448	1,492
Hulless Barley	White	1.5	1,278	1,248	1,263
Spring Wheat	Wild Goose	1.5	1,302	1,078	1,190

It will be observed from the figures here given that the Emmer produced a greater yield of grain per acre throughout Ontario than any other class of grain, the average yield being 1,968 pounds, while that of the Mandscheuri barley was 1,915 pounds, and that of the Siberian oats, 1,796 pounds per acre.

In connection with the results of experiments conducted with different crops both at the College and throughout Ontario, it is interesting to compare the average production of some of the principal spring crops throughout Ontario as recorded in the Reports of the Bureau of Industries. In taking the average production of farm crops of Ontario for twenty-one years, and also for the past two years, we obtain the following figures :

	Averge 21 years.	Average 1902 and 1903.
Barley	1,272 lbs. per acre.	1,613 lbs. per acre.
Oats	1,200 lbs. per acre.	1,431 lbs. per acre.
Peas	1,164 lbs. per acre.	1,107 lbs. per acre.
Beans	1,040 lbs. per acre.	918 lbs. per acre.
Spring Wheat	942 lbs. per acre.	1,176 lbs. per acre.
Rye	918 lbs. per acre.	983 lbs. per acre.

It will be seen that the yield per acre of nearly all of the farm grains throughout Ontario has been much greater in the average of the last two years than in the average of the past twenty-one years. It will also be observed that the results for the co-operative experiments throughout Ontario are greater than those obtained in general farm practice, and also that the yields at the College are considerably higher than any of the others here presented. It should be remembered, of course, that the results at the College and also those in connection with the co-operative work were obtained from plots, and that the other results were obtained from larger areas of land.

Experiments in Plant Breeding.

A considerable amount of work has been done recently with the object of improving some of the best varieties of farm crops by means of plant breeding. For this purpose, two lines of work have been followed : (1) A systematic method of selection, and (2) A combination of careful selection and artificial cross fertilization. A number of hybrids of wheat, oats, and barley have been obtained, and it is hoped that, in due time, varieties will be secured which are better suited to the conditions of Ontario than even the best kinds in our possession at the present time. This is work, however, which requires much time, patience, and labor before the desired results can be secured.

Influence of Seed Selections Upon the Resulting Crop.

Within the past ten years, a large amount of very careful work has been done to determine the influence of different selections of seed upon the resulting crop. The reader's attention is directed to the results of this experiment, which are becoming more valuable from year to year, owing to the increasing number of times that the experiment has been repeated. Fresh seed has been taken each year from the general crop of grain grown either in the Farm or in the Experimental Department. It will, therefore, be understood that whatever difference there is from the influence of the selection of seed, that difference is attributed entirely to the careful selection of seed for the separate years in which the tests were made. For the large, plump seed, none but well-developed grains were selected; for the small, plump sample the grains selected were of a uniform character; and for the shrunken sample, none but shrunken grains were used, the last selection being made regardless of the size of the kernels. The sample of broken grain, in the case of barley, contained nothing but grains which were broken crosswise; split grain, in the case of winter wheat, contained nothing but grains which were broken lengthwise; and split seed, in the case of peas, contained peas which were split, but not broken. The grain from which these selections were made was all threshed with a grain separator, and the splitting and the breaking of the grains were, therefore, done in the usual process of threshing. In the selection of large plump seed, one-half pound was carefully weighed from each class of grain. The number of large plump seeds of each kind of grain was then counted, and a correspond-

ing number was taken of the medium-sized grain, the small plump grain, the shrunken grain, and the broken grain. The different selections were sown upon plots of similar size. The average results of this experiment are here presented in tabulated form :

Seed Grain Selections.

Class of grain.	Number of years that tests have been repeated.	Selections.	Weight of grain per measured bus.	Average yield per acre. (From 6 to 9 years.)	
				Tons of straw.	Bush of grain (by weight).
Oats	7	Large seed	33.2	1.9	62.0
		Medium sized seed	32.2	1.8	54.1
		Small seed	31.8	1.8	46.6
Barley	6	Large plump seed	49.5	1 5	53.8
		Small plump seed	48.8	1.5	50.4
		Shrunken seed	49 1	1.4	46.0
		Broken seed	48 6	1.3	43 2
Winter Wheat	6	Large plump seed	59.4	2.6	46.9
		Small plump seed	59.2	2.2	40 4
		Shrunken seed	59 1	2.1	39.1
		Split seed	54.2	.6	9.3
Spring Wheat	8	Large plump seed	59.1	1.4	21.7
		Small plump seed	58 3	1.3	18 0
		Shrunken seed	56.9	1.2	16 7
Peas	6	Large seed	56.3	1.3	28 1
		Small seed	56.3	1.1	23 0
	9	Sound seed	58 1	1.4	29.2
		Split seed	57.9	.6	10.2

As the tabulated results indicate so clearly the comparative productions from the different selections of seed, it requires but few words to show the great importance of sowing seed of the best quality. In the average of seven years' experiments, large oats produced about 8 bushels per acre more than medium-sized seed, and an average of 15½ bushels per acre more than small seed. Large plump barley gave a yield of nearly 8 bushles per acre more than that produced from shrunken seed in the average results of experiments repeated for six years in succession. Split peas and broken wheat gave exceedingly poor results, while broken barley produced fully as large yields as one would naturally expect., The broken barley, however, produced more than 10 bushels per acre less than the large plump seed.

Continuous Selection of Seed Oats for Eleven Years in Succession.

For eleven years in succession, an experiment has been conducted in breeding oats by means of selection. The selections made were large, plump, well-developed seeds; light-weighing and light-colored seeds; and also seeds from which the hulls had been removed by the separator. The test was commenced in the spring of 1893 by selecting seed from the general crop of Joanette oats of the previous year. The selection made in each of the following years has been from the product of the selected seed of the previous year. The number of grains used on each plot was carefully counted, and an equal number was used of each selection in the number of years in which this experiment has been conducted. As the selection for this experiment has been continuous, selecting the seed each year from the crop produced in the year previous, the average results are of but little value, but the final results are interesting, valuable and quite suggestive. In the crop produced in 1903, it was found that the large plump seed produced 76.9 bushels ; the light seed, 57.7 bushels; and the hulled seed, 72.2 bushels per acre. As only the best quality of seed becomes hulled, we find that the oats from

Group of students at the close of a practical lesson in grain judging.

which the hulls had been removed gave nearly as good results as the carefully selected, large, plump seed from which the hull had not been removed in the process of threshing. In weight per measured bushel, the crop produced from the large plump seed weighed 7½ pounds more than that produced from the light seed, and about 1-3 of a pound more than that produced from the hulled seed. The difference throughout between the large, plump, well-developed seeds and the light-weighing and light-colored seeds is very marked, and shows the great importance of sowing the former and discarding the latter.

It is interesting to notice that the crop produced from the large plump seed required only 1,208 grains to weigh an ounce, while the crop produced from the light seed required 1,586 grains to make the same weight. The average number of hulled grains per ounce in the crop of 1903 produced from the different selections is as follows: Hulled seed, 238; large plump seed, 220; and light seed, 74. This seems to show that, by sowing hulled seed continuously, there is a tendency to produce oats with a hull which is more easily separated from the kernel in threshing than that which has been grown from unhulled seed.

The Production of Grain and Straw from Different Grain Mixtures.

In an extensive experiment conducted for six years in succession in growing oats, spring wheat, barley, and peas, separately, and in various combinations, for the production of grain and straw, it was found that a mixture of oats and barley gave the highest yield of grain per acre.

Different Proportions of Oats and Barley. Having ascertained that a mixture of oats and barley was well adapted to a large production of grain, it became of importance to know the best proportions of these grains to use in the mixture to give the most satisfactory returns. It was, therefore, decided in the spring of 1900 to conduct an experiment in sowing nine different proportions of oats and barley in order to determine which mixture and which quantity of seed would give the best results in the production of grain and straw. The following gives the amounts of oats and barley per acre used for seed in the different mixtures, and also the number of pounds per acre produced from the different mixtures in the average of four years' experiments:

(1) Oats, ½ bushel, and barley, ½ bushel, yield, 2,250 pounds.
(2) Oats, ½ bushel, and barley, 1 bushel, yield, 2,166 pounds.
(3) Oats, ½ bushel, and barley, 1½ bushels, yield, 2,232 pounds.
(4) Oats, 1 bushel, and barley, ½ bushel, yield, 2,355 pounds.
(5) Oats, 1 bushel, and barley, 1 bushel, yield, 2,347 pounds.
(6) Oats, 1 bushel, and barley, 1½ bushel, yield, 2,338 pounds.
(7) Oats, 1½ bushel, and barley, ½ bushel, yield, 2,231 pounds.
(8) Oats, 1½ bushel, and barley, 1 bushel, yield, 2,271 pounds.
(9) Oats, 1½ bushel, and barley, 1½ bushel, yield, 2,133 pounds.

As this experiment was conducted in three places in the experimental grounds in each of the years 1900 and 1901, and in two places in each of the years 1902 and 1903, the figures here presented give the average of ten separate tests. It is quite evident that the mixtures containing 1 bushel of oats give decidedly better results than the mixtures containing either ½ bushel or 1½ bushels of oats. In 1900, and again in 1901, very excellent results were obtained from 1 bushel of oats and 1½ bushels of barley per acre. In the last two years, however, the best results have been obtained from a lighter seeding of barley, owing, probably, to the comparatively wet seasons of each of the past two years. In 1903, the greatest yield was obtained from 1 bushel of oats and ½ bushel of barley per acre.

Barley and Oats with Some Additional Variety of Grain. In 1902, and again in 1903, an experiment was conducted in duplicate in order to ascertain whether the seed mixture of 1 bushel of oats and 1½ bushels of barley per acre could be improved by the addition of a small quantity of some other kind of seed. In addition to the oats

and barley, ½ bushel of grain was used in each mixture. The average results of the two tests for each of the years 1902 and 1903 are as follows : (1) Oats and barley, 2,607 pounds; (2) Oats, barley and spring wheat (Wild Goose), 2,657 pounds; (3) Oats, barley, and Emmer, 2,673 pounds; (4) Oats, barley, and hulless barley (black), 2,601 pounds; (5) Oats, barley, and flax, 2,627 pounds, and (6) Oats, barley, and grass peas, 2,591 pounds. It will, therefore, be seen that the highest yield was produced from oats, barley, and Emmer, and the lowest yield from oats, barley, and grass peas.

Methods of Cultivation.

In each of the past three years, an experiment has been under way in comparing different methods of cultivation, for both oats and barley. The experiment was conducted in duplicate in each year. The results which follow, therefore, represent the average of six separate tests : (1) Cultivated six inches, drilled, rolled, and harrowed,—average yield per acre : Oats, 56.4 bushels, and barley, 44.9 bushels ; (2) Cultivated three inches, drilled, rolled, and harrowed,—average yield per acre : Oats, 56.8 bushels, and barley, 43.2 bushels ; (3) Cultivated three inches, drilled, and rolled,—average yield per acre : Oats, 58.6 bushels, and barley, 46.2 bushels ; and (4) Cultivated three inches and drilled,—average yield per acre : Oats, 54.5 bushels, and barley, 42.4 bushels. It will be observed that the land which was cultivated three inches deep and was then drilled and rolled gave the largest yield of grain per acre of both oats and barley. It should be remembered that the summers of 1902 and 1903 were comparatively wet and cool. The soil on which this experiment was conducted was what might be termed as average clay loam. This experiment will likely be repeated for several years.

Treatment for Smut in Oats and Winter Wheat.

Many enquiries have been made by Ontario farmers regarding the treatment of smut in both oats and wheat. As different treatments are recommended for smut in each of these grains, experiments have been conducted at the College for two years with oats and for four years with winter wheat in order to ascertain the most effectual remedies which can be used in Ontario.

Treatment of Oats for Loose Smut. Two varieties of oats were selected in the spring of 1902, and again in the spring of 1903, and uniform samples of each variety were submitted to special treatments, with the object of killing the spores of smut adhering to the grain. The various treatments were as follows :

(1) Immersion in Hot Water. For this treatment, the grain was placed in a bag, which was then immersed in water at about 115 degrees F. Soon afterwards it was placed in water which was kept at a temperature between 130 degrees and 135 degrees F. The grain was occasionally stirred and was allowed to remain in the water for a period of fifteen minutes. It was then spread out on a clean floor to dry, where it was stirred occasionally.

(2) Immersion in Bluestone Solution for five minutes. For No. 2 treatment, a strong solution was made by dissolving one pound of Copper Sulphate (Bluestone) in one gallon of water, and then immersing the oats in the solution for a period of five minutes.

(3) Immersion in Bluestone Solution for twelve hours. In this treatment, the bluestone solution was made by dissolving one pound of bluestone in 25 gallons of water, and the oats were immersed in this solution for a period of twelve hours.

(4) Sprinkling with Bluestone Solution. This solution was made by dissolving one pound of bluestone in 10 gallons of water, which was used for sprinkling over the oats until they were thoroughly moistened after being carefully stirred.

(5) Immersion in Potassium Sulphide Solution. The potassium sulphide treatment consisted in soaking the seed for two hours in a solution made by dissolving 8 pounds of potassium sulphide in 50 gallons of water.

(6) Immersion in Diluted Formalin. The solution of formalin used for the immersion process was made by pouring one-half pint of the formalin into 21 gallons of water, and the seed oats were immersed in the solution for twenty minutes.

(7) Sprinkling with Diluted Formalin. One-half pint of formalin was poured into 5 gallons of water. The oats were then sprinkled with this solution and carefully stirred until the grain was thoroughly moistened.

(8) Untreated. One sample of oats of each variety was left untreated in order that the influence of the various treatments might be observed.

Eight lots of oats of each variety were, therefore, used for this experiment. After the treatments had been completed a few hours, the oats were carefully sown on separate plots. Each plot was exactly one rod square in size. When the oats were coming into head, they were examined frequently, and all smutted heads removed and carefully counted. The four separate tests have been averaged, and the following table gives the results in the percentage of smutted heads of oats from each treatment :

Treatments.	Percentage of Smutted Heads.	
	1903.	Average of 2 years.
1. Immersion in hot water	.0	.0
2. Immersion in bluestone solution for five minutes	.9	1.3
3. Immersion in bluestone solution for twelve hours	.0	.3
4. Sprinkling with bluestone solution	2.0	1.4
5. Immersion in potassium sulphide solution	.1	1.7
6. Immersion in diluted formalin	.0	.0
7. Sprinkling with diluted formalin	.0	.0
8. Untreated	3.9	4.7

The treatments with hot water, formalin, and twelve hours immersion in bluestone solution gave the best results in each of the two years. The formalin treatment is easily performed, comparatively cheap, and very effectual. The untreated seed had an average of 4.7 per cent. of smutted grain. That would amount to a loss of about 25 bushels in a ten-acre field of oats. In those seasons in which the smut is very bad, the treatment would likely prevent a much greater loss than here indicated.

Treatment of Winter Wheat for Stinking Smut. Winter wheat infested with smut has been treated in different ways in each of four years. The crop produced in each year from the various treatments was carefully examined. The following gives the average for the four years :

Untreated ..... 456 smut balls per pound of wheat.
Potassium Sulphide ..... 11 smut balls per pound of wheat.
Copper Sulphate ..... 2 smut balls per pound of wheat.
Hot Water ..... 1 smut ball per pound of wheat.

The copper sulphate (Bluestone) treatment consisted in soaking the seed for twelve hours in a solution made by dissolving one pound of copper sulphate in 24 gallons of water, and then immersing the seed for five minutes in lime water, made by slacking one pound of lime in 10 gallons of water. The hot water treatment consisted in immersing the wheat for fifteen minutes in water at 132 degrees F. After each treatment, the grain was spread out and stirred occasionally until dry enough to sow.

Influence of Different Latitudes on Seed Oats and Seed Wheat.

Arrangements are made by which the Missouri Agricultural Experiment Station and our College exchange seed wheat and seed oats yearly, with the object of studying the

influence of environment on the production of seed grain. The final results of this experiment cannot be obtained for several years. The results of past experiments have generally shown that the southern grown oats have produced the largest yield of grain, and that the Ontario seed produced grain of the best quality. The Dawson's Golden Chaff seed wheat grown in Ontario has given slightly better results in 1902-3 than that imported from the State of Missouri.

Grains Sown at Different Dates.

It is certainly surprising that so little has been done in the past with the object of obtaining reliable information regarding the best date to sow our various grain crops in order to secure the greatest production of the best quality. It is true that seasons vary, but data obtained from experiments carried on for a number of years furnish information which becomes exceedingly valuable as a general guide. The results which follow have been obtained from experiments conducted at the College :

Winter Wheat. Two varieties of winter wheat have been sown on different dates in the autumn for a period of nine years, and the average results show that the wheat which was sown during the last week in August, or the first ten days in September, yielded better than that sown at a later date. In 1903, the highest average yield was obtained from sowing on September 9th, 1902.

Ordinary Spring Grains. For six years in succession, an experiment has been conducted by sowing spring wheat, barley, oats, and peas, on six different dates in the spring of the year. The first seeding took place as soon as the ground was sufficiently warm and dry to work to good advantage. One week was allowed between each two seedings. The average results go to show that the largest yields of grain were obtained from the first seeding with spring wheat, and from the second seeding with barley, oats, and peas. The results indicate the importance of sowing spring wheat, barley, oats, and peas in the order here given, starting with the spring wheat and finishing with the peas. After the first week was past, however, there was an average decrease in yield from every day's delay in seeding of 56 pounds of oats, 53 pounds of barley, 29 pounds of spring wheat, and 23 pounds of peas per acre.

Spelt and Emmer. Although both of these classes of grain are, in reality, different species of wheat, we present the results under a separate heading. Both spelt and emmer were sown on eight different dates in the spring of 1903, starting on April 2nd and finishing on May 21st, and allowing one week between each two dates of seeding. The results of the experiment are given in the table here presented :

Dates of Seeding. 1903.	Lbs. per Measured bus.		Tons of Straw per acre.		Lbs. of grain per acre.	
	Spelt.	Emmer.	Spelt.	Emmer.	Spelt.	Emmer.
April 2nd	28.8	39.6	2.3	2.5	34.99	42.97
" 9th	27.9	37.9	2.0	2.6	30.61	39.78
" 16th	28.0	38.1	2.3	2.5	25.70	36.94
" 23rd	25.4	36.9	2.1	2.7	17.13	37.25
" 30th	26.4	36 9	2.1	3.0	16.58	40 67
May 7th	25.7	37.4	2.1	2.6	14.28	32.19
" 14th	24.0	37.0	1.9	2.7	9.61	31 77
" 21st	27.5	36 6	1.8	2.9	6.58	31.03

The results of the experiment conducted in 1903 show that the emmer produced straw which yielded more abundantly, and grain which weighed heavier per measured bushel and yielded more per acre, than that of the spelt from each of the dates of seeding. It will also be observed that the emmer gave good results throughout the whole season, furnishing 4,297 pounds of grain per acre from the first seeding, and

3,103 pounds of grain per acre from the last date of seeding. In the case of the spelt, however, the results are very different. There was a rapid decrease in the yield of grain per acre from the first to the last date of seeding, there being 3,499 pounds from the first, and 658 pounds from the latest date on which the grain was sown. These figures seem to indicate that the emmer not only surpasses the spelt in yield of grain per acre from the first date of seeding, but will permit much later seeding than the spelt. This experiment will likely be repeated for several years.

Winter Wheat Seed Per Acre.

From sowing, one, one and one-half, and two bushels of winter wheat per acre for each of six years, average yields of 40.2 bushels, 43.3 bushels, and 43.9 bushels per acre, respectively, were obtained. As two varieties of wheat were used each year, these averages represent twelve distinct tests.

Methods of Sowing Winter Wheat.

Winter wheat which was sown broadcast by hand gave practically the same results as that which was drilled in with a machine in the average results of tests made in each of eight years. The land was in a good state of cultivation in every instance.

Preparation of the Land for Winter Wheat.

In an experiment conducted for four years, winter wheat grown on land on which a crop of field peas was used as a green manure, produced an annual average of 22.1 per cent. more wheat per acre than on land where a crop of buckwheat was plowed under. In another experiment which was carried on for one year, winter wheat grown on land prepared from clover stubble produced 20.7 per cent. more wheat per acre than on land prepared from timothy stubble. In a two years' test with commercial fertilizers, an application of 160 pounds of nitrate of soda per acre increased the yield of wheat 18.8 per cent., or 7.2 bushels. The present price of nitrate of soda is about $60 per ton.

Winter Wheat Cut at Different Stages of Maturity.

For seven years in succession, five plots of each of two varieties of winter wheat were sown at the same time in the autumn, and cut at five different dates in the following summer—a week being allowed between each two dates of cutting. Seed from each of the seventy cuttings was sown, and the crop therefrom was harvested when ripe. In the average results of these tests, it is found that the heaviest weight of grain per measured bushel and the largest yield of both grain and straw were produced from seed taken from the crops which had become very ripe by remaining uncut for the longest period of time.

Varieties of Wheat.

We have sometimes heard the remark that grain growing in Ontario is largely a thing of the past, owing to the development of the live stock and dairy industries. This statement is apt to be very misleading, as there is actually about 15 per cent. more grain grown at the present time than there was ten years ago. The great change has not been so much in the amount of grain which is grown as in the method of handling the crop after it is secured. Formerly a large amount of grain was sold from the farm, while, at the present time, a greater proportion is fed to live stock, and the sales which are made are principally those of farm stock and dairy products. This change in method has also brought about a change in the relative amounts of the different grains grown in Ontario. The area devoted to the growth of those

IMPERIAL AMBER WINTER WHEAT.
(*Triticum vulgare.*)

RED FIFE SPRING WHEAT.
(*Triticum vulgare.*)

POLISH SPRING WHEAT.
(*Triticum Polonicum.*)

WILD GOOSE SPRING WHEAT.
(*Triticum durum.*)

a. Front of grain. *b.* Side of grain. *c.* Back of grain. *d.* Empty glume. *e.* Flowering glume. *f.* Palet.

crops which can be used to the best advantage as feed for farm stock has been increased, and that used for the growing of those crops which are more suitable for selling directly from the farm has been decreased. Hence we can probably see the reason why there has been a decrease within the last five years of 36 per cent. in the area devoted to winter wheat growing, and of 35 per cent. in the area devoted to spring wheat growing in Ontario. Even after this decrease, we find that there were nearly a million acres under wheat in Ontario in 1903.

RED SPELT.
(*Triticum spelta.*)

COMMON EMMER.
(*Triticum dicoccum.*)

a. Front of grain. *b*. Side of grain. *c*. Back of grain. *d*. Front of spikelet. *e*. Side of spikelet.

The wheat plant appears to have been known and valued from the earliest times, as it will thrive successfully in a great range of climate, the inhabitants of many countries enjoying the advantages of its cultivation. Most authorities classify wheat into seven distinct types, which include all varieties. The seven types are as follows :

(1) Common, fine, or soft wheat (Triticum vulgare).
(2) Turgid or toulard wheat ,Triticum turgidum).
(3) Hard or flinty wheat (Triticum durum).
(4) Polish wheat (Triticum polonicum).
(5) Spelt (Triticum spelta).
(6) Starch wheat (Triticum dicoccum).
(7) One-rowed wheat (Triticum monococcum).

Representatives of all these different classes have been grown in our experimental grounds, although practically nothing is known throughout the Province about varieties of either turgid wheat or the one-rowed wheat. Considerable, however, has been said in reference to representatives of each of the other classes.

Common Wheat (Triticum vulgare). This class represents the greatest number of the varieties of both winter and spring wheats which are grown in Ontario for flour production.

The winter wheat crop of the present year has been unusually good. The yields have been high and the quality of the grain has been excellent, some of the varieties weighing as much as 63.8 pounds per measured bushel. The rust did not cause any serious damage, and the Hessian fly has apparently disappeared for the present.

Upwards of two hundred varieties of winter wheat have been grown at the College within the past fourteen years. The most of these have been grown for at least five years in succession. The following figures represent the average results for five years of some of the best varieties in yield of both straw and grain per acre, and in weight of grain per measured bushel:

Varieties.	Color of grain.	Tons of straw.	Pounds per bus.	Bushels per acre.
Dawson's Golden Chaff	White	4.2	59.7	63.5
Imperial Amber	Red	4.4	61.0	61.0
Prize Taker	White	4.2	59 0	60.3
Early Genesee Giant	White	4.5	59.9	60.1
Rudy	Red	3.9	61.0	57.7
McGarvin	Red	3.9	61.1	57.7
Egyptian Amber	Red	4.6	61.8	57 5
Early Red Clawson	Red	4.1	59.4	57.4
White Golden Cross	White	4.5	58.9	57 3
Buda Pesth	Red	3.9	61.3	57.2
Michigan Amber	Red	4.6	60.2	55.4
Treadwell	White	4.0	61.0	54.2
Turkey Red	Red	3.7	61.5	53.4
Bulgarian	White	3 9	61.1	53.0

It will be seen that the Imperial Amber stands second in average yield of grain per acre, and is a close rival to the Dawson's Golden Chaff in grain production. It has a bearded head, red chaff, and a red grain. A drawing of the head, grain, and chaff of the Imperial Amber is presented in this report.

The Dawson's Golden Chaff produces stiff straw and soft grain, and the Turkey Red, weak straw and hard grain. We have made several crosses between these two wheats, and hope to secure a new variety with the productive power and the stiffness of straw of the Dawson's Golden Chaff, and the quality of grain of the Turkey Red.

In 1902, Ontario millers were desirous to have the Turkey Red, Michigan Amber, Early Genessee Giant, and Bulgarian varieties of winter wheat grown throughout the Province, owing to their superior milling qualities.

The varieties of winter wheat which we have grown for less than five years, and which produced the greatest yields of grain per acre in 1903, are as follows : (1) New American Banner, (2) Abundance, (3) No. 6, (4) Cap Sheaf, (5) Silver Dollar, (6) Paramount, (7) Forty-fold, (8) Superlative, (9) Prosperity, (10) Winter King, (11) Fultzo-Mediterranean, and (12) Banatka.

In spring wheat for flour production, the average results of five years' experiments with fifteen varieties show that the Pringle's Champion stands at the top of the list, and the Red Fife next to the top in yield of grain per acre. These two varieties have given an average of 37.9 and 37 bushels of grain per acre, respectively. The Red Fife, which has been grown in Ontario more or less for a good many years, and which is sown so extensively in Western Canada, is one of the best varieties of spring wheat for flour production which we have grown at the College. In those sections of Ontario where spring wheat can be grown successfully, the Red Fife variety seems about as likely to give satisfactory results in both yield of crop and quality of grain as any other variety of the common spring wheats which we have tested for a series of years. The reader is referred to a drawing of the head, grain, and chaff of the Red Fife spring wheat, which is given in this report.

Hard or Flinty Wheat (Triticum durum). This class includes a number of varieties of wheat which are frequently used for the manufacture of macaroni. Some seven varieties in all have been grown at the College for at least five years in succession. The greatest average yield during the five years has been obtained from the Wild Goose variety, which produced slightly over 41 bushels of grain per acre. The Sorentino comes second with 38 1-2 bushels, and the Medeah third with 37 bushels per acre. In weight per measured bushel, the Wild Goose also occupies highest place, the average for the five years being 62 pounds. For fuller information in reference to Wild Goose spring wheat, the reader is referred to the accompanying cut, and to the remarks under the next heading, where this variety is compared with the Polish wheat.

Polish Wheat (Triticum polonicum). A cereal under the name of "Corn Wheat" is being extensively boomed in the Western States at the present time. As many extravagant claims are made for this grain, it is quite natural that our own people should be enquiring about this peculiar wheat, and wondering if it would produce such immense crops in Canada. From enquiries which we have made, we learn that the so-called "Corn Wheat" is no other than the grain known in various countries by the name of Polish Wheat (Triticum polonicum). This name has been changed to "Giant Rye," in Colorado, and now to "Corn Wheat" in Idaho.

The Polish Wheat is grown more or less in Egypt, Algiers, Spain, Italy, and Eastern Europe, and to a very limited extent in America. The straw is of medium length and is almost solid. The heads are large, and the outer chaff projects beyond the inner chaff in a peculiar manner. The grains are about one and one-half times as large as those of the Wild Goose spring wheat, and are hard, transparent, and suitable for the manufacture of macaroni.

We first grew the Polish Wheat at the Ontario Agricultural College, Guelph, in 1889. Careful tests of its comparative results along with other varieties have been made for at least nine years. As the Wild Goose spring wheat is the best known macaroni wheat in Eastern Canada, I submit the comparative yields of these two varieties as grown under similar conditions at the Ontario Agricultural College in each of nine years. The following table gives the number of weighed bushels (60 pounds) produced by each variety in each of the years indicated:

Years.	Polish Spring Wheat.	Wild Goose Spring Wheat.
	bus.	bus
1889	11.7	26.7
1890	8.9	12.9
1897	16.3	23.1
1898	27.1	48.3
1899	24.5	44.5
1900	34.5	48.4
1901	15.6	32.1
1902	29.1	33.5
1903	32.8	46.7

In the average results for the nine years, we find that the yield of the Polish Wheat was 22.3 bushels, and that of the Wild Goose was 35.1 bushels per acre. The Wild Goose variety, therefore, gave an average yield of 57.4 per cent. more than that of the Polish Wheat. The average weight per measured bushel of the Wild Goose wheat was 62.1 pounds, and that of the Polish Wheat was 56.5 pounds. The light weight per measured bushel of the Polish Wheat is largely due to the fact that the grains are very long and large, and do not lie closely together when in bulk. The Polish Wheat ripens about one day earlier than the Wild Goose variety, and possesses straw which measures two inches shorter, and weighs about one-third of a ton per acre less per annum than the latter wheat. The Polish Wheat usually stands up

fairly well, but the straw is more subject to rust than that of the Wild Goose. The peculiarities of the head, grain, and chaff of the Polish Wheat can be seen from the accompanying illustration (see page 126).

We have never distributed the Polish Wheat for co-operative testing among the farmers, the reasons for which are possibly apparent to the reader after a perusal of the foregoing results.

Spelt (Triticum spelta). Spelt is a cereal which in appearance is intermediate between wheat and barley, but, in reality, is one of the types into which wheat is divided. It is a native of the countries near the Mediterranean Sea. At the present time it is grown principally on the poorer soils in Switzerland, Southern Germany, and Northern Spain. It is also grown at an elevation in Switzerland where the common wheat (Triticum vulgare) will not thrive. For general cultivation it is considered much inferior to the finer varieties of wheat. The head is open, narrow, bearded or bald, and is usually very long. When the grain is threshed, the head breaks into pieces at the different joints, or nodes, leaving the grain still clasped firmly by the chaff. In order to make a separation of the chaff from the seed, special machinery is required. The grain is medium hard, and somewhat compressed at the sides. The grain in Ontario frequently called Spelt belongs to the Emmer class, and is, therefore, improperly named.

To find out the value of Spelt for growing in Ontario, we have imported at different times no less than ten varieties from Switzerland, Russia, Germany, the Argentine Republic, and the United States. Two of these varieties proved entire failures, two others gave poor results, and the other six varieties yielded moderately well. As the grain is enclosed by a chaff somewhat similar to oats, and weighs less than 40 pounds per measured bushel, the results here presented are given in pounds, instead of bushels of grain per acre. One of the best varieties of Spelt has now been grown in the experimental plots for five years, and has given an average yield of 1,623 pounds of grain per acre. For further particulars in reference to Spelt, the reader is referred to the accompanying drawing, and also to the results under the next heading.

Emmer (Triticum dicoccum). Emmer is a cereal which represents a different type of wheat from any of those already described in this report. It is grown in Russia, Germany, Switzerland, Spain, France, Italy, and to a slight extent in some other countries. In Russia, alone, about sixteen million bushels are produced annually.

As in the case of Spelt, the grain of the Emmer is tightly enclosed within the chaff, from which only a small portion is separated, even in the process of threshing. In comparison with Spelt, however, the heads are much shorter and more compact, and the grain is more triangular in form and very much harder. The spikelets of the Emmer overlap each other like shingles on a roof, which makes the head close, smooth, and regular. The heads are nearly always bearded, and the chaff is usually harder than that of the Spelt. The portion of the stem adhering to the spikelets after threshing is much smaller and more pointed in the Emmer than in the Spelt. The spikelets of the Emmer are flattened on the inner side, while those of the Spelt are arched. Emmer is considered a very hardy plant, being much superior to the Spelt in this respect. The comparative difference between Spelt and Emmer can be plainly seen by the drawings shown on another page. These drawings may reveal to some people in Ontario the fact that the grain which they have been growing under the name of Spelt is, in reality, Emmer, a cereal which is quite distinct from Spelt.

Emmer has been grown in the Experimental Department for four years, and has produced very heavy yields of grain per acre. The yields in each of the past four years for the common variety of Emmer are as follows: 1900, 2,608 pounds; 1901, 2,122 pounds; 1902, 2,252 pounds; and 1903, 3,924 pounds, thus making an average of 2,727 pounds per acre. The weight per measured bushel was 43.8 pounds in 1900,

33 8 pounds in 1901, 36.6 pounds in 1902, and 36.6 pounds in 1903, the average being 37.7 pounds. It will be seen that the average yield of Emmer per acre for the four years has been fully 72 bushels per acre by measure.

Emmer was distributed for co-operative experiments throughout Ontario in 1901, 1902, and again in 1903, and the yields produced throughout the Province were very large, being higher than the average yields of the best varieties of oats or barley.

The following table gives the average results of two years' experiments in growing four varieties of Spelt and three varieties of Emmer under similar conditions :

Classes of crop.	Varieties.	Average results for two years.					
		Percentage of			Pounds per bu. one year.	Yield per acre.	
		Rust	Crop lodged.	Hull with grain.		Tons of straw.	Pounds of grain.
Emmer	Common	2	12	23	36.6	2.6	3,474
	Iowa	2	11	22	38.4	2.3	3,235
	Russian	2	8	23	37 0	2.2	3,143
Spelt	Red	15	5	30	27 6	2.2	2,374
	A'stroum	18	5	30	27.5	1.8	2,174
	White	16	3	30	28.4	1.7	2,050
	Dasyanthum	19	25	37	28.0	2.1	1,902

The table here presented shows some very interesting results. The straw of Emmer is very clean, being almost free from rust, while that of Spelt is quite subject to the attacks of this fungus. As a rule, however, the Emmer is a little weaker in the straw than the Spelt, although the Dasyanthum variety of Spelt is decidedly weaker than any variety of Emmer which we have had under experiment. It will also be observed that the majority of varieties of Emmer contain only 23 per cent., while those of Spelt contain about 30 per cent. of hull. As the average hull on oats is about 30 per cent., it will be seen that Emmer, as a class, has decidedly less hull than either Spelt or oats. According to the results of the past two years, the average weight per measured bushel of Emmer was about 10 pounds greater than the average weight per measured bushel of the Spelt. Although there is not much difference in the length of straw of the two classes of grain, it will be seen that the Emmer produces a little heavier weight of straw per acre than is obtained from the Spelt. From the last column in the table, in which the average yield of grain of each variety of Emmer and of each variety of Spelt is given, it will be seen that the poorest variety of Emmer has given 769 pounds per acre more than the best variety of Spelt. In all experiments which we have made at the College, every variety of Spelt has been surpassed in yield of grain per acre by every variety of Emmer.

As the results of all experiments which we have yet conducted with these two classes of grain, we find the Emmer to be decidedly the most promising to grow in Ontario. As it requires special machinery for separating the hull from the grain of Emmer, and as the grain when ground makes rather a coarse flour, it is likely that this grain will not be grown in Ontario extensively for flour production. It is quite probable, however, that it will be grown considerably for the producton of good, clean straw, and a large yield of grain to be used as a food for live stock. For feeding purposes, the grain and the surrounding chaff are usually ground together in the same manner as oats are ground into meal.

Winter Rye.

Two varieties of Winter Rye have been grown for five years in succession, and the following average yields of straw and grain per acre have been obtained : Mam-

moth, 4 tons straw, 60.8 bushels grain ; and Common, 4.1 tons straw, and 57.2 bushels grain.

Spring Rye.

The average yields per acre of the Dakota Mammoth and Prolific Spring varieties of rye for six years, and the Common Rye for five years, are as follows : Dakota Mammoth, 39.5 bushels ; Prolific Spring, 36.5 bushels ; and Common Rye, 35.9 bushels. The weight per measured bushel in the same experiment we find to be 57.9 pounds for the Dakota Mammoth, 57.1 pounds for the Prolific Spring, and 56.6 pounds for the Common. The results of experiments carried on with both Winter Rye and Spring Rye seem to show that the average results in yield of grain per acre are decidedly in favor of the Winter Rye.

Winter Barley.

Winter Barley has been tested for ten or twelve years. It is more tender than winter wheat, becoming completely killed out in some years. When it survives the winter, however, it usually gives a very high yield of grain, the average for seven years being 68.7 bushels per acre.

Varieties of Spring Barley.

Barley is one of the hardiest of the cereals, and can be raised through a great range of climate. It is cultivated with success north of the Arctic circle, and at high altitudes in the torrid zone. In 1903 no less than 709,839 acres were devoted to this crop in the Province of Ontario.

Six-rowed Barley. In the five years from 1889 to 1893, eighty-six different varieties of barley were grown in the experimental grounds. After five years' tests were completed, the poorest varieties were dropped from the experiment, and those which proved the most successful were retained for future experiments. New varieties were added from time to time, all of which were tested for at least five years. In the average results of ten years' experiments with each of nine different varieties of six-rowed barley, we find yields as follows : Mandscheuri, 70.9 bushels ; Oderbrucker, 66 bushels ; Scotch Improved, 66.2 bushels ; Common Six-rowed, 65.5 bushels ; Mensury, 64 bushels ; and Success, 47.8 bushels per acre. Although a great deal has been claimed for the Success barley, which is an early variety and free from beards, we find that in the average of the last ten years it has produced fully 20 bushels per acre less than the Mandscheuri variety. In the average results for the last five years, we find that the California Brewing, Mandscheuri, Common Six-rowed, Oderbrucker, and Scotch Improved have been the best yielding six-rowed barleys. Some new varieties imported from Great Britain and Germany, and grown in our trial grounds for one or two years, are promising.

Two-rowed Barley. The two-rowed barley is easily distinguished from the other species by the head being more elongated, and by their being two distinct rows of grain from one end of the head to the other. The heads of some varieties are long and slender, while those of other varieties are short, very broad at the base, and taper towards the extremity. The two-rowed barley is largely cultivated in England and in Central Europe, but it is not grown to any great extent in Ontario, although great efforts were made a few years ago by the Dominion Government to have it grown more extensively by Canadian farmers for exporting to England. With this object in view, the Canadian Government imported 10,000 bushels of the Carter's Prize Prolific barley from England, and sold the same to Canadian farmers at $2 per bushel in order to get it introduced.

About sixty varieties of two-rowed barley have been grown in our experimental grounds at the College. According to the results of several years' experiments.

we find that the highest yielding two-rowed barleys are not as productive as the most prolific varieties of the six-rowed class. In the average of ten years' results with eight varieties of two-rowed barley, we find the greatest yields produced by the two-rowed Canadian, Vermont Champion, Gold Foil Hansford, New Zealand Chevalier, and French Chevalier. In 1903, the greatest yields of two-rowed barley were produced from two varieties which came through the United States Department of Agriculture, namely, Imported No. 5,591 and Hanna No. 5,590. Some English and German varieties imported by the College are also promising. The Chevalier Two-rowed barley has been used considerably in mixing with Siberian or Banner oats for seed purposes. As the Chevalier barley is late in maturing, it ripens about the same time as either of these varieties of oats, and a mixture composed of these grains usually produces a heavy yield per acre.

Hulless Barley. A considerable amount of Hulless barley is grown in some parts of Ontario, especially in those sections where the pea weevil (pea-bug) has been doing serious damage to the pea crop in recent years, and where farmers are using the Hulless barley as a partial substitute for the pea crop. The yield of grain of the Hulless barley is usually very good, but, generally speaking, the straw is weak. When sown with oats, however, the crop seems to stand up rather better than when sown alone. The standard weight per measured bushel of Hulless barley is 60 pounds.

Eight varieties of Hulless barley have been grown in the experimental grounds at Guelph in each of the past ten years, and the highest average yields were obtained from the following varieties: Guy Mayle, 48.8 bus.; Black Hulless, 45.6 bus.; and Purple, 45.2 bushels per acre. In the average results for the past five years, we find the greatest yields were obtained from the Guy Mayle, 52.6 bus.; Black Hulless, 50 bus., and Purple, 48.1 bushels per acre. These three kinds of Hulless barley are among the best varieties which we have tested at the College.

Varieties of Oats.

The wide range of soils on which oats grow to advantage, and the comparatively low temperature in which they come to their maturity, have rendered them well adapted for cultivation in many countries. In Scotland, we find oats cultivated to its northern extremity, and in Norway they grow as far north as latitude 65 degrees.

The area devoted to oats in Ontario annually, is about equal to that used for all the other cereals combined.

We have had in our experimental grounds at the College no less than two hundred and sixty-five different varieties of oats, in order to secure information as to the most suitable varieties for general cultivation throughout the Province. In the average results for fifteen years of eight different varieties of oats, we find the greatest yields obtained from the Joanette, 88.9 bus.; Siberian, 87.2 bus.; and Oderbrucker, 81.5 bushels per acre. The Joanette oats, possessing a very short straw, are unsuitable for growth throughout the greater part of the Province. On rich soils, however, where they are sown very thinly, cut a little on the green side, and bound into small sheaves, they are grown with great satisfaction by some farmers. They are the greatest stooling oats and possess the thinnest hulls of all the varieties which we have had under experiment at the College. For general cultivation throughout the Province, however, the Siberian and the American Banner varieties are two of the most popular. The Siberian seems to give the best results in some localities, and the American Banner in others. In the average results of experiments with twenty-five varieties of oats for the past five years, the greatest yields have been obtained from the Siberian, Liberty, American Banner, German, Rust-Proof, and Michigan Wonder, in the order here indicated. Among the newer varieties of oats, the Liberty and Sensation are promising for general cultivation; the Daubeney and Alaska for very early maturity, suitable for growing by themselves in Northern Ontario, or for mixing with barley in

Southern Ontario; and the Tartar King where a stiff coarse straw is specially desirable.

Varieties of Corn for Grain.

In spite of the fact that the number of silos throughout Ontario has been increasing from year to year, we find that the area devoted to corn for husking is also increasing throughout the Province. In 1903, 378,924 acres were used for the cultivation of corn for the production of grain. This was the greatest amount of Ontario land ever used for this purpose.

In the average of four years' experiments in growing nine early varieties of corn for grain production, we have obtained the following yields of shelled grain :

King Phillip	58.1 bus. per acre.
Farmer's Friend	54.2 bus. per acre.
Longfellow	53.5 bus. per acre.
Genesee Valley	52.6 bus. per acre.
Canada Yellow	47.7 bus. per acre.
Red Blazed	46.9 bus. per acre.
Burlington Hybrid	45.0 bus. per acre.
Salzer's North Dakota	43.2 bus. per acre.
Compton's Early	41.6 bus. per acre.

The King Phillip variety, which stands at the head of the list in yield of grain per acre, also gave the highest yield of grain in the co-operative experiments throughout Ontario in 1903. The North Star Yellow Dent variety, which gave excellent results in grain production at the College in 1900, 1901, and again in 1902, did not fully mature in the past year.

Varieties of Millet for Seed.

In each of six years, different varieties of millet were grown and ripened, and the yield of seed of each carefully determined. In the average results for these years, it is found that the California and the Siberian varieties, and also the Hungarian Grass, have all produced large yields. The Japanese Panicle millet has usually made high records in yield of seed per acre, but, through the unfavorable weather of the last two years, it has not given quite as good results as it has in other years when the weather was both warmer and drier.

Varieties of Field Peas.

Owing to the severe ravages of the pea weevil (pea bug) in the southern part of Ontario, it has been thought wise to drop experiments with field peas both at the College and throughout the southern part of Ontario, with the hope that farmers generally will follow the example and quit growing peas entirely for a period of two years. For fuller information in reference to this interesting subject, the reader is referred to a bulletin prepared by Prof. Lochhead and myself, and issued by the Department of Agriculture, copies of which can be procured by writing to the Department of Agriculture, Parliament Buildings, Toronto, Ontario.

The results reported in the bulletin of experiments conducted at the Ontario Agricultural College in growing peas and in combatting the pea weevil, as well as the information obtained from some of the most extensive growers, merchants, millers, and exporters of peas in Ontario, lead us to make the following recommendations :

(1) That the acreage of both field and garden peas of the very best varieties be greatly increased in those sections of the Province where there are no pea weevils ;

(2) That the growing of both field and garden peas (to be ripened) in the weevil-infested districts of Ontario be discontinued for the next two years, and such crops as Early Yellow Soy beans, Grass peas, Emmer (improperly called Spelt), mixed grains, etc., be substituted ;

(3) That if any persons continue to grow and ripen peas in the infested districts, they make the best possible use of the fumigation method ;

(4) That seedsmen, farmers, and others send no infested peas into those districts of Ontario where the pea weevil does not exist ; and

(5) That farmers, gardeners, seedmen, millers, exporters, importers, and all others who have anything to do with the growing or handling of peas in Ontario, co-operate heartily in the effort to eradicate the pea weevil from Ontario within the next two years.

Hairy Vetches Grown for Seed.

For three years in succession, Hairy Vetches have been sown in the autumn and ripened in the following year, with the result that an average of 10.8 bushels of seed per acre has been obtained. The vetches sown in the autumn have been somewhat more productive of seed than those sown in the spring of the year. In past years, the Hairy Vetch seed has been principally imported from Germany, and has usually cost fully $5 per bushel. The Hairy Vetches produce a crop which seems specially useful as a pasture for farm stock, especially hogs; a cover crop in orchards ; or a green manure for plowing under to enrich the soil.

Varieties of Beans.

Thirteen varieties of beans have been under experiment in our trial grounds at the College in each of the past seven years, and the exact yield of each determined every season. In averaging the results for the seven years, we find the highest yields produced by the White Wonder, 22.8 bus.; Pearce's Improved Tree, 22.2 bus.; Medium or Navy, 21.7 bus.; Burlingame Medium, 21.6 bus.; Schofield Pea, 21.1 bus.; Day's Improved Leafless, 20.8 bus.; and Buckbee's Electric Tree, 20.5 bushels of seed per acre. The smallest average yield of beans was produced by the Large White Haricots, the yield being 13.3 bushels per acre. The Large White Haricots weighed, on an average, only 56.1 pounds per measured bushel, which was the lowest weight per bushel of all the varieties under test. Each of eight varieties gave an average weight per measured bushel of between 65 and 66 pounds, the heaviest being the Snowflake, 65.9 pounds, and the Buckbee's Electric Tree, 65.5 pounds. A variety grown in our plots in 1903 for the first time under the name of New Prize Winner gave exceptionally fine results this season, being one of the heaviest yielding varieties under test.

Varieties of Soy, Soja, or Japanese Beans.

The interest which is being taken in the Soy beans is created from the fact that some of these varieties can be grown successfully in Ontario, and that the crop is exceedingly rich in valuable constituents as a feed for farm stock. The whole plants are richer in flesh-forming constituents than Common Red Clover, and the grain is richer than any other grains which are grown in Ontario as feed for live stock. Many of the varieties of Soy beans require too long a season to give satisfactory results in Ontario. After experiments for a number of years, however, the Early Yellow variety has given good satisfaction as a grain producer, and the Medium Green variety as a fodder crop. We believe that as the Medium Green variety becomes better known, it will be grown for the purpose of cutting green and mixing with corn when filling the silo. From what we know of the Soy beans, we believe that the addition of the Medium Green variety to fodder corn when filling the silo would increase the quality of the latter greatly, would make a much better balanced ration than the corn alone, and would require less meal in order to secure satisfactory results.

Varieties of Sugar Beets.

Within the past few years, Ontario farmers have taken a good deal of interest in the cultivation of sugar beets, some of them by growing sugar beets as food for live stock, and others by growing the beets for factory purposes. Usually those varieties which give a large yield per acre, are easily harvested, and contain an average of about ten per cent. of sugar are the ones grown for feeding purposes, and those var-

ieties which grow mostly under ground and furnish about fifteen per cent. of sugar are the ones sown when sugar production is the chief aim in view. Experiments have been carried on in the experimental grounds with different varieties of sugar beets for the past ten years. Some of these varieties were specially adapted to the production of sugar, and others to the production of food for live stock. The following list gives the yield per acre in the average of ten years' experiments with each of eight varieties of sugar beets grown in the experimental grounds :

Red Top	19.8 tons	White French	18.4 tons
Lane's Improved	19.5 tons	Red Skinned	17.0 tons
White Silesian	19.5 tons	Kleinwanzlebener	16.7 tons
Champion	18.8 tons	Improved Imperial	14.9 tons

For eight years in succession, three other varieties have been grown under uniform conditions with those already mentioned, the average yield per acre for the eight years of each of these varieties being as follows : New Danish Improved, 21.8 tons ; Jersey, 19.1 tons ; French Yellow, 18.0 tons. The Green Top White, which has been grown for six years, produced an average yield of 21.3 tons, and the Vilmorin's Improved, which has been grown for five years, produced an average yield of 10.6 tons per acre.

Within the last four years, a greater number of varieties of sugar beets have been grown in the experimental grounds than in any previous year. In 1900 and in 1901, the sugar beet seed was planted in rows 26 inches apart, and the plants were thinned to a distance of 7.9 inches apart in the rows. In 1902 and in 1903, however, all the varieties were planted in rows 21 inches apart and a distance of 7 inches was left between the plants in the rows. The following table gives the average yield per acre of duplicate experiments conducted with nineteen varieties in 1900, twenty-one varieties in 1901, thirty varieties in 1902, and thirty-two varieties in 1903 :

Varieties.	Yield of roots per acre.				
	1900. Tons.	1901. Tons.	1902. Tons.	1903. Tons.	Average. Tons.
1 New Danish Improved	19.10	18.60	27.88	27.44	23 21
2 Red Top	24.25	19.63	26 81	20.83	22.88
3 Royal Giant	14 95	19.29	29.63	26.55	22.61
4 Giant Rose Feeding Sugar	14.50	17.67	25.38	31.11	22.17
5 Giant White Feeding Sugar	14.05	17 22	25.38	31.53	22 05
6 Red Skinned	21.55	20.60	22.38	22.36	21.72
7 White French	17.35	14 39	29.06	26 08	21 72
8 White Silesian	21.45	18.15	25 94	21.23	21.69
9 Carter's Nursery	13 35	14.93	29.38	27.02	21.17
10 Green Top White	18.35	18 91	26.56	20.47	21.07
11 Lane's Improved	20 45	16.28	22 75	22.08	20 39
12 Champion	19.25	17.18	22 38	21.00	19 95
13 Queen of the Danes	11.65	12.63	26 00	29.27	19 89
14 Kleinwanzlebener	14.38	16.81	23.06	20.97	18 81
15 Jersey	13.70	14.63	20.69	23.06	18 02
16 Imperial Grey Top	11.85	15.87	21 81	22.39	17 98
17 French Yellow	13.15	15.14	23.19	19.48	17.74
18 Pitzscheke's Elite	14.85	14.61	20.63	20 70	17 70
19 Improved Imperial	14.00	14 22	21 31	19.83	17.34
20 Mangel Sugar Beet		13.01	20.50	21.27	18.26
21 Vilmorin's French Sugar		13.22	19 44	21.45	18.04
22 Ideal			30.13	31.69	30.91
23 Rennie's Giant Sugar			33 00	26.50	29 75
24 Tankard Cream			28 56	28.75	28 66
25 Kleinwanzlebener (Mette)			21.50	22.44	21.97
26 Jaensch's Victrix			21.44	21.23	21.34
27 Rubensamen (Rimpau)			21.06	19 67	20.37
28 Dieckman No. 3			20 44	19.86	20.15
29 Dieckman No. 1			19.63	19.33	19.48
30 Dieckman No. 2			19.13	18.52	18 83
31 Hybrid Sugar Beet Mangel				25.23	25.23
32 Imperial Giant Half Sugar				25.02	25.02

It will be observed from the accompanying table that the variety of sugar beets known as the Ideal, which has been grown in the experimental grounds for only two years, produced the second highest yield of roots per acre among thirty varieties in 1902, and the highest yield among thirty-two varieties in 1903. It will be seen that the Kleinwanzlebener, which is the variety principally used for the production of beets for the four factories now manufacturing sugar in Ontario, yielded 14.4 tons in 1900, 16.8 tons in 1901, 23.1 tons in 1902, and 21 tons per acre in 1903,—making an average of nearly 19 tons per acre for the four years. Varieties, such as the New Danish Improved, Red Top, and Royal Giant, which produce heavy crops per acre, contain a much less percentage of sugar than the Kleinwanzlebener variety, and are thus not nearly as suitable for factory purposes. A number of the varieties near the end of the list, which have been grown for only two years, were imported from Germany. They were obtained from different sugar beet breeders in Germany who have made a specialty of selecting beets for years in order to obtain a high percentage of sugar. For the results of the chemical analyses of these beets, the reader is referred to the report of the Chemical Department, written by Prof. Harcourt, in a previous portion of this volume.

Planting Sugar Beets at Different Distances Between Drills.

An interesting experiment was conducted in our trial grounds in 1902 and again in 1903 by planting sugar beets in rows nine different distances apart. The experiment was conducted in duplicate each year. There were seven rows in each plot, each row being four rods in length. The variety of sugar beets known as the Kleinwanzlebener was used throughout. The average results of the experiments are here presented in tabulated form:

No.	Distances.	Average of four tests.		
		Average Weight per root 1902-3.	Yield of tops per acre. 1902-3.	Yield of roots per acre. 1902-3.
		Lbs.	Tons.	Tons.
1	12 inches apart	.65	13.30	23.41
2	14 " "	.74	9.43	22 92
3	16 " "	.81	10.49	22.51
4	18 " "	.87	9.65	21.31
5	20 " "	.99	10.04	21.72
6	22 " "	1.05	10.51	21.41
7	24 " "	1.11	9.50	20.59
8	26 " "	1.18	9.43	20.50
9	28 " "	1.21	9.40	19.19

In the average results of the two tests made in each year, it was found that, as the distance between the rows increased, there was a gradual increase in the average size of the roots, and, with two or three slight exceptions, a decrease in the yield of roots per acre. The roots which were grown in rows 18 and 20 inches apart, which are the usual distances to grow sugar beets for the production of sugar, produced an average yield of about two tons per acre more than the average yield produced from rows 28 inches apart, which is about the distance usually left between the rows when growing sugar beets for feeding purposes. Samples from the various parts of this experiment were taken to the chemical laboratory, and were analysed by Prof. Harcourt in order to ascertain the percentage of sugar from beets grown in rows at different distances apart. For the results of these analyses, the reader is referred to the report of the Chemical Department, to be found earlier in this volume.

Thinning Sugar Beets at Different Distances in the Drills.

An experiment was conducted in 1903 for the first time by planting sugar beets in rows 18 inches apart, and thinning the plants in the rows to the distances of two, four, six, eight, and ten inches apart. Each plot consisted of six rows, fifty links (two rods) in length. The Kleinwanzlebener variety of sugar beets was used in the experiment, which was conducted in duplicate. The average of the two tests made in 1903 shows the average yield per acre from the different distances of thinning the plants to be as follows : 2 inches apart, 21 tons; 4 inches apart, 18.3 tons; 6 inches apart, 17 tons ; 8 inches apart, 15.9 tons ; and 10 inches apart, 15.7 tons. However, we find that from the plants thinned at different distances, we obtained the following average weight per root : 2 inches apart, 9.6 ozs.; 4 inches apart, 14.7 ozs.; 6 inches apart, 1 lb.; 8 inches apart, 1 lb. 2 ozs.; and 10 inches apart, 1 lb. 11 ozs. These results show that as the distance between the roots increased, there was a gradual increase in the average size of the roots and a gradual decrease in the average yield of roots per acre. The results of experiments presented under the last two headings show that the Kleinwanzlebener variety of sugar beets produced a larger yield per acre when the plants were comparatively close together than when they were thinned to a greater distance apart.

Flat and Ridged Cultivation for Sugar Beets.

In 1902, and again in 1903, an experiment was conducted in growing sugar beets on the flat as compared with ridged cultivation. The Kleinwanzlebener variety was used throughout. Each plot consisted of six rows, each row being fifty links (two rods) in length. Twenty-one inches were allowed between the rows, and seven inches between the plants in the row. The experiment was conducted in duplicate each year. The average yield of sugar beets per acre from the flat cultivation was 20.6 tons in 1902, and 21 tons in 1903, while that from the ridged cultivation was 19.8 tons in 1902, and 19.7 tons in 1903. It will, therefore, be seen that in the average of two years' experiments the land which was cultivated on the flat produced a little more than one ton of sugar beets per acre more than the land which was ridged up at the time when the sugar beet seed was sown.

Selection of Sugar Beet Seed.

Each sugar beet seed, as it is usually sown, contains one, two, three, or more germs, and is, therefore, capable of producing from one to at least four plants. The seed, as it is sown, therefore, is usually a cluster of seeds. The selection of seed in the case of sugar beets is, therefore, necessarily somewhat different from that of carrots or turnips. In order to ascertain the comparative value of different sized sugar beet seed clusters as they are usually sown, an experiment has been conducted by sowing large, medium, and small seed clusters in each of five years. The experiment has been conducted in two sections. In one section, only one seed cluster of each selection was planted in one place, and in the other section, three large seed clusters, five medium-sized seed clusters, and eight small seed clusters were planted in each place. Each section of the experiment was conducted in duplicate. The first section allowed a better determination of the comparative germination of the seed clusters, and the second section afforded a better opportunity for thinning the plants and getting a more uniform stand of roots. It has been found that a better stand of roots, however, can be obtained from three large seed clusters than from five medium-sized seed clusters; and also a better stand of roots from five medium-sized seed clusters than from eight small seed clusters. Averaging the results of the four tests made in the each of the five years, we obtain the following yields of sugar beets per acre : Large seed clusters, 22.9 tons; medium-sized seed clusters, 21.9 tons; small sized seed clusters, 14.3 tons.

Soaking Sugar Beet Seed Before Planting.

An experiment was conducted in 1903 for the first time by planting unsoaked seed and seed which had been soaked twelve, twenty-four, and thirty-six hours before it was planted. The experiment was conducted in duplicate. In each test, the unsoaked seed gave slightly the lowest yield per acre. The average results of the two tests in 1903 show that the highest yield, 15.8 tons, was obtained from the seed soaked for twelve hours, and the lowest yield, 13.9 tons, was obtained from the seed which had not been soaked.

Varieties of Potatoes.

The potatoes grown in Ontario for the past twenty years have had an annual average market value of fully seven millions of dollars. According to the Report of the Bureau of Industries, the largest average yield of potatoes per annum obtained within the last ten years was 159 bushels per acre, and the lowest average yield of potatoes per annum was 84 bushels per acre. The highest yield was obtained in 1895, and the lowest in 1898. The average yield per acre of potatoes grown in Ontario in the last twenty-one years has been 115 bushels.

Eighty-eight varieties of potatoes were grown in the experimental grounds in 1903. The potatoes were planted on the 30th of May in rows 26 2-5 inches apart, and the cut pieces were placed one foot apart in the rows. The potatoes were planted about four inche deep, and the land received level cultivation throughout the season. A combination of Bordeaux mixture and Paris Green was applied on three different occasions.

The varieties which gave the largest yield of sound potatoes per acre in the experiments conducted in 1903 were as follows : Empire State, 336.7 bus.; Pearl of Savoy, 325.4 bus.; Seedling No. 230, 322.1 bus.; Up-to-date, 315 bus.; Salzer's Earliest, 312.9 bus.; American Wonder, 312.1 bus.; White Elephant, 309.1 bus.; Dempsey's Seedling, 306.3 bus.; New Main Crop, 288.8 bus.; and Howe's Premium, 281.7 bushels. Those giving the smallest yield per acre were the Carter's Royalty, 95 bushels, and Skerries, 102.9 bushels.

As potatoes rotted quite badly throughout many sections of Ontario during the past year, and as those grown at the College did not escape the disease, we have some interesting results in regard to the susceptibility of the different varieties to the ravages of this disease. A very careful count was made of all sound potatoes, and all rotten potatoes at the time of digging the different varieties. Another careful examination was made after the potatoes had been harvested about three weeks, and the rotten ones were separated from the others and counted. This enabled us to ascertain the exact percentage of rotten potatoes of each variety in 1903. The results show that the smallest amount of rot was obtained from the following varieties : Robertson's Champion, ½ per cent.; Green Bay, 2 per cent.; Holborn Abundance, 2 1-5 per cent.; Stray Beauty, 2½ per cent.; Bliss Triumph, 2½ per cent.; Salzer's Earliest, 3 per cent.; Up-to-date, 3 per cent.; Early Pinkeye, 3 per cent.; Seedling No. 230, 4 per cent.; and Skerries, 6 per cent. The varieties which contained the greatest amount of rot in 1903 were the Beauty of Hebron, 58 per cent.; White Pinkeye, 56 per cent.; New Queen, 55 per cent.; Weld's Orange, 53 per cent.; Burnaby Mammoth, 52 per cent.; Brown's Prolific, 50 per cent.; Leamington, 50 per cent.; Hanlan Beauty, 50 per cent.; Montana Bluff, 49 per cent.; and Rose's New Invincible, 48 per cent.

In the average results of the different varieties of potatoes grown for ten years in succession, the Empire State, Pearl of Savoy, Rose's New Invincible, Rural New Yorker No. 2, American Wonder, and White Elephant have been among the very heaviest yielders.

In each of two years, about two hundred varieties were carefully tested for table quality. The Empire State was found to be one of the best varieties for table use as well as for producing an abundant crop.

Six rows of each of twelve very early varieties were planted in the spring of 1903. Two rows of each variety were dug and weighed at the end of nine weeks, two other rows at the end of twelve weeks, and the two remaining rows at the end of fifteen weeks after planting. There was but very little rot in these very early potatoes this year. In this experiment, which was conducted in duplicate, the following varieties produced the largest average yields of potatoes per acre at nine weeks after planting: Acme, 233 bus.; Early Dominion, 215 bus.; Early Andes, 214 bus.; and Early Ohio, 210 bushels.

In the average results of eight years' experiments in digging early potatoes nine weeks after planting, the following yields per acre have been obtained: Stray Beauty, 107 bus.; Early Ohio, 105 bus.; Early Dominion, 101 bus.; Howe's Premium, 99 bus.; and Burpee's Extra Early, 79 bushels.

Different Methods of Treatment for the Potato Beetle.

For eight years in succession, an experiment has been conducted at the College by using different methods of treatment for destroying the potato beetles (bugs). In each of these years, the treatments which were made were as follows: Paris Green and water, Paris Green and plaster, and Potato Bug Finish. All the treatments were made from two to four times in each season, according to requirements. One plot in every test was allowed to remain untreated. The average results of the eight years' experiments give the following yields per acre:

Nothing ..... 81.0 bushels.
Potato Bug Finish ..... 124.5 bushels.
Paris Green and Plaster ..... 130.9 bushels.
Paris Green and Water ..... 138.2 bushels.

In six out of the eight years, the Paris Green and water gave the highest yield per acre, and in each of the eight years the untreated potatoes gave decidedly the lowest yield per acre.

In 1902, and again in 1903, six lots, of each of two varieties of potatoes, were carefully selected and planted on twelve separate plots. After the potatoes had made sufficient growth and the potato beetles (bugs) had made their appearance, five plots of each variety were treated in different ways to destroy the beetles, and one plot of each variety was left untreated as a basis of comparison. The five treatments made in each of the years were as follows: (1) Paris Green and water, using one pound of Paris Green in 96 gallons of water per acre; (2) Paris Green with plaster, using one pound of Paris Green and 38 pounds of plaster per acre, and applying the mixture to the potatoes in the dry condition; (3) Potato Bug Finish, which was applied dry at the rate of 20 pounds per acre; (4) Bug Death and water, using 32 pounds of Bug Death mixed in 96 gallons of water per acre; and (5) Bug Death, used in the same proportion as in No. 4, but in the dry condition. Three applications of each of the five treatments were made in both years. In the autumn, the potatoes from each of the twelve plots were dug and weighed. The following are the average results in yield of potatoes per acre:

Treatments.	Yield of sound potatoes per acre.		
	Average two varieties. 1902.	Average two varieties 1903.	Average two years 1902 and 1903.
	Bushels.	Bushels.	Bushels.
Nothing	68 0	124.6	96.3
Paris Green and Water	123.5	172.7	148.1
Paris Green and Plaster	136.7	160 6	148.7
Potato Bug Finish	107.0	166 7	136 8
Bug Death and Water	163.4	192.9	178.2
Bug Death Dry	168.9	219.4	194.2

The Bug Death is manufactured at St. Stephen, N.B., and has recently been introduced into Ontario. It was tested in our trial plots at the Agricultural College in 1902 for the first time. It has certainly made an excellent record in each of the past two years The potato tops on which the Bug Death was applied were more vigorous in growth and greener in appearance throughout each of the seasons than those on which the other applications were made. The usual prices of these insecticides when bought in quantity are about as follows : Paris Green, 20 cents per pound ; Bug Death, 8 cents per pound; and Potato Bug Finish, 1 2-3 cents per pound. The cost, therefore, for the material used in the experiment conducted in 1902 and again in 1903 was about as follows : Paris Green and water, 60 cents per acre; Paris Green and plaster, 88½ cents per acre; Bug Death, $7.68 per acre ; and Potato Bug Finish, $1.00 per acre.

Bordeaux Mixture for the Potato Blight

It is very seldom that the potatoes grown in the experimental plots have been injured with rot. In some places, the rot has proven very troublesome, and excellent results have been obtained by the use of the Bordeaux mixture along with the Paris Green, the first spraying being done when the plants were about six inches in height, and the second and third sprayings at intervals of ten to fifteen days. In some cases, five or six sprayings of Bordeaux mixture have been made in the same season.

In 1903 an experiment was conducted in our experimental plots by spraying two varieties of potatoes with Paris Green and Bordeaux mixture, and also the same two varieties of potatoes with Paris Green alone. The potatoes for this experiment were planted on June 10th, and the sprayings took place on July 11th, July 23rd, and August 6th. The Bordeaux mixture was made in the same way and in the same proportions as described in the College Bulletin, No. 122, copies of which can be obtained from the Department of Agriculture, Toronto, Ontario. The results of the experiment show that an average yield of 188 bushels of sound potatoes was obtained from the treatment of a combination of Paris Green and Bordeaux mixture, and 173 bushels of potatoes per acre from the Paris Green solution alone. There was considerably less rot in those potatoes on which the Bordeaux mixture was used. Bug Death appeared to exert almost exactly the same influence as Bordeaux mixture in preventing the rot in 1903.

Varieties of Mangels.

Thirty-three varieties of mangels were grown in the experimental grounds under similar conditions in 1903. Each variety consisted of three rows, each row being four rods in length. The rows in all cases were 26 2-5 inches apart. The plants were thinned to a distance of ten inches apart in the rows.

The greatest yields per acre in 1903 were obtained from the Yellow Leviathan, 43.1 tons, and the Sutton's Mammoth Long Red, 42.4 tons. All other varieties gave less than 40 tons of roots per acre.

Fifteen varieties of mangels have been grown for six years in succession. The five varieties which have produced the greatest average yield of roots per acre for six years are as follows : Yellow Leviathan, 33.5 tons; Sutton's Mammoth Long Red, 33.2 tons; Oblong Giant Yellow, 32.6 tons ; Mammoth Golden Giant, 32.2 tons; and Steele-Briggs Giant Yellow Intermediate, 31.8 tons. The Yellow Leviathan variety generally produces roots which are smooth on the surface, yellow in color, compact in form, and intermediate in length. The Yellow Leviathan was distributed throughout Ontario in connection with the co-operative experiments in 1903 for the first time. According to the reports of the experimenters, it was the most popular of the three varieties distributed. The seed of this variety was obtained from D. M. Ferry, seedsman, Windsor, Ontario.

Soaking Mangel Seed Before Planting.

An experiment has been conducted for two years in succession by planting mangel seed which had been soaked for twelve, twenty-four, and thirty-six hours, and also mangel seed which was unsoaked. As the result of the two years' experiments, the mangel seed which was soaked for twelve hours gave the largest yield of roots per acre. This experiment will likely be repeated for several years.

Planting Mangel Seed at Different Depths.

For five years in succession, mangel seed has been planted in the experimental grounds at five different depths. The experiment was conducted in duplicate each year. The following are the average results of the ten tests made in the five years, and represent the yield of roots per acre from each depth of planting: ½ inch, 23.6 tons; 1 inch, 19.8 tons; 1½ inches, 19.3 tons; 2 inches, 17.9 tons; 3 inches, 13.8 tons; and 4 inches, 6.3 tons.

Breaking of Mangel and Sugar Beet Seeds or Clusters.

The mangel and sugar beet seed as purchased is usually quite uneven in size and difficult to sow evenly over the ground. Each seed usually contains from one to four, and sometimes even as high as seven germs, which produce one, two, three, or more plants. It will, therefore, be seen that what is usually called a seed is actually a number of fruits united together in a cluster. Experiments have been conducted at the College in each of the past two years to ascertain whether these seed clusters could be broken in such a way that the seed could be sown more evenly over the soil and the thinning of the roots be accomplished with less difficulty. The seeds, however, adhere so closely to the surrounding matter that it is very difficult to break the clusters without injuring the seeds. Our work so far in trying to shell seed has not proven satisfactory, as we have obtained considerably better results from the seed clusters which were left unbroken than from those which were broken, or crushed.

Preparation of Land for Mangels.

In the spring of 1901, a strip of land two rods in width and forty rods in length was divided into thirty-two plots. Paths five links (39.6 inches) in width were allowed between the plots. The land is very level throughout, and had been uniformly cropped previous to the date here mentioned. In the spring of 1901, the whole range was sown to early oats. No. 1 plot was seeded with Common Red Clover, No. 2 plot with Alsike Clover, No. 3 plot with Timothy, and No. 4 plot received no clover or grass seed. Similar seedings to these were repeated until the whole range was seeded according to the plan outlined above. It will, therefore, be seen that there were eight plots of Common Red Clover, eight plots of Alsike Clover, eight plots of Timothy, and eight plots left without seeding. After the oats were cut, the plots were carefully edged. Both the clover and the timothy made good growth in the autumn. In the following spring, the growth of the three crops on each of the twenty-four plots was excellent. The range was divided into two sections, and each section into four divisions, each division containing one plot of Common Red Clover, one plot of Alsike Clover, one plot of timothy, and one plot without any crop. The land in No. 1 division was plowed after the first crop of the season had received its full growth and before it had been removed from the land; No. 2 division was plowed immediately after the first crop of the season had been removed; No. 3 division was plowed before the second crop had been removed; and No. 4 division was plowed immediately after the second crop had been removed from the land. The remaining eight plots were an exact duplicate of the first section. The land was cultivated on the surface in the autumn and was sown with

mangels in the spring of 1903. The Sutton's Mammoth Long Red variety was used in the first section, and the Yellow Leviathan variety in the second section. The average results of the two sections show that the clover sod gave decidedly better results than the timothy sod. The greatest average yield of roots per acre (35.5 tons) in 1903 was produced on land in which the first crop of Alsike Clover had been plowed in. This land produced 5¼ tons per acre more than that on which the first crop of timothy was plowed in. Taking the average of all the experiments in 1903, we find that the Common Red Clover land produced 2.1 tons, and the Alsike Clover land, 3.6 tons per acre more than the timothy land. It is intended to sow these plots with another crop in 1904, and with still another crop in 1905, in order to study the manurial effects of the different crops plowed under for a series of years. This whole experiment will likely be repeated several times.

Varieties of Swede Turnips.

A large number of varieties of Swede turnips have been carefully tested in the experimental grounds in past years. As the result of these experiments, it is found that there is a very great difference in the productiveness and the quality of the different varieties. In the average of five years' experiments, five of the largest yielding varieties have made the following yields per acre: Sutton's Magnum Bonum, 21.5 tons; Buckbee's Giant, 20.1 tons; Hartley's Bronze Top, 19.4 tons; Kangaroo, 18.7 tons; and Hall's Westbury, 18.7 tons.

Varieties of Fall Turnips.

As in the case of Swede turnips, a large number of varieties of the fall, or soft, turnips have been grown in the experimental plots for several years in succession. The following represents some of the best varieties in the experiments covering a period of five years: Red Top White Globe, 27.5 tons; Early American Purple Top, 21.1 tons; Cow Horn, 18.7 tons; Green Barrel, 18.4 tons; and Jersey Navet, 18.2 tons per acre. It will, therefore, be seen from the average results for five years, that the Red Top White Globe has given decidedly the largest yield of roots per acre. The roots of this variety are usually firm, and are not generally troubled much with rot, which affects some varieties very seriously in the autumn of the year.

Varieties of Carrots.

Twenty-four varieties of carrots were sown on the 9th of May in 1903. Of these varieties, three gave upwards of 40 tons of roots per acre, viz., Mammoth Intermediate Smooth White, 42.9 tons; Steele's Improved Short White, 41.3 tons; and Mastadon White Intermediate, 40.3 tons. In the average results of sixteen varieties grown under uniform conditions in each of six years, we find the greatest yields produced by the following sorts: Mammoth Intermediate Smooth White, 31.3 tons; Mastadon White Intermediate, 31.1 tons; Steele's Improved Short White, 30 tons; Inversion's Champion White Intermediate, 29.1 tons; and Simmers' Short White Vosges, 28.3 tons per acre. In comparison with these, we find that the Half Long Stump Rooted yielded only 20.7 tons, and the Danver's Orange only 21.3 tons per acre.

Depth of Planting Carrot Seed.

In each of four years, an experiment has been conducted in duplicate by planting carrot seed at six different depths in the soil. The land was cultivated on the level throughout. The average of the ten tests made in the five years shows that the following yields per acre have been obtained from seeds planted at the depths here indicated: ½ inch, 13.4 tons; 1 inch, 13.4 tons; 1½ inches, 8.7 tons; 2 inches, 4.4 tons; 3 inches, 1.2 tons; and 4 inches, 1.3 tons.

Varieties of Parsnips.

Numerous enquiries have been received regarding the advisability of growing parsnips with the object of using the roots as a food for farm stock. As little information could be obtained in reference to the growth of parsnips as a field crop, some experiments have been conducted with different varieties of parsnips in order to obtain some information along this line. Six varieties were grown in 1903. The highest yield per acre was obtained from the Buckbee's New Sugar Parsnip (14.8 tons), and the lowest yield per acre from the Garton's Common Field Cattle Parsnip (7.1 tons). The first of these has been grown for four years, and the last for only two years. Three varieties have been grown in each of six years, and the results show the following yields of roots per acre : Improved Half Long, 11.8 tons; New Ideal Hollow Crown, 11.7 tons; and Improved Long Smooth, 11.1 tons per acre.

Varieties of Corn for the Production of Fodder or Silage.

One hundred and thirty-five varieties of corn were grown in the experimental grounds in 1903. Owing to the peculiar weather conditions in each of the past two years, only about twenty of these varieties reached maturity in time for cutting in the autumn. The greatest total yields in 1903 were produced by the following kinds : New Century Wonder, 29.3 tons; Cloud's Early Yellow, 26.9 tons; Eureka, 26.9 tons; Pennsylvania Early Dent, 26.4 tons; Mastadon Dent, 26.3 tons; and 100 Day Bristol, 26.2 tons. Although the New Century Wonder produced decidedly the greatest yield of total crop per acre, it was exceedingly late and very deficient in ears, the yield of ears being only about two-fifths of a ton per acre, while that of Cloud's Early Yellow was 3.7 tons; Eureka, 3.4 tons; 100 Day Bristol, 3.2 tons; Mastadon Dent, 3.2 tons; and Pennsylvania Early Dent, 2.2 tons per acre.

A large number of varieties of corn have been grown for several years in succession, the results of which form a better basis for the selection of leading varieties than those obtained from the experiments of the past year. Of all the varieties which have been grown for several years in succession, we find that the Mammoth Cuban and the Mastadon Dent are varieties which give excellent satisfaction on the warm soils of Southern Ontario, where large varieties of corn can be grown successfully ; that the Wisconsin Earliest White Dent gives a good yield of total crop per acre, which is of excellent quality, this variety producing the largest yield of ears per acre among sixty-seven varieties grown for five years in succession, and being well suited to the central part of Ontario where the frosts are not too severe; and that the three flint varieties,—Salzer's North Dakota, Compton's Early, and King Phillip,—and one dent variety, North Star Yellow Dent, have given good results and are well suited for the central and northern part of Ontario.

Corn Planted at Different Depths.

For five years in succession, an experiment has been conducted by planting corn ½ inch, 1 inch, 1½ inches, 2 inches, 3 inches, and 4 inches below the surface. The experiment was conducted in duplicate each year, and the land was cultivated on the level throughout. As the average results of the ten different tests made in the five years, we have obtained the following yields per acre : ½ inch: 11 tons total crop, 2.4 tons ears; 1 inch: 14.3 tons total crop, 2.5 tons ears; 1½ inches: 13.4 tons total crop, 2.3 tons ears; 2 inches: 15.1 tons total crop, 2.6 tons ears; 3 inches: 13.8 tons total crop, 2.4 tons ears; and 4 inches: 12.6 tons total crop, 1.9 tons ears. From these results, it will be seen that the greatest yield of both total crop and ears per acre was obtained from planting at a depth of 2 inches upon soil which might be termed an average clay loam. The planting usually took place in the last week of May.

Methods of Cultivating Corn.

In 1902, and again in 1903, an experiment was conducted by cultivating corn in four different ways. The North Star Yellow Dent variety of corn was used in the experiment, and the experiment was conducted in duplicate each year. Each test consisted of four plots. The average results of the two tests made in each of two years are as follows: (1) Deep cultivation at first, gradually getting shallower as the season advanced, 23 tons per acre; (2) Shallow cultivation throughout the season, 22.7 tons per acre; (3) Deep cultivation throughout the season, 21.6 tons per acre; and (4) Shallow cultivation at first, gradually getting deeper as the season advanced, 21.6 tons per acre. From these results, it will be seen that in seasons such as we have had in the past two years, corn which was cultivated deeply immediately after it was planted, and in which the cultivation was shallower as the season advanced, produced the greatest yield, while that which was cultivated shallow at first and deeper as the season passed by, produced a lighter yield by 1 2-5 tons per acre.

Varieties of Sorghum for Fodder.

Fifteen varieties of sorghum have been tested in the experimental grounds in each of the years 1899, 1900, 1901, 1902, and 1903. These include different varieties of Sugar Cane, Broom Corn, Kaffir Corn, Millo Maize, etc. Some of the varieties of sorghum have been extensively advertised as very valuable crops to be grown for stock feeding. A few of these, such as the Early Amber Sugar Cane, have given very good results in some sections of the Province. The average results of the five years' experiments with each of fifteen varieties are here presented:

Varieties.	Average height 5 years.	Yield per acre. Average 5 years.	
		Heads.	Total crop.
	Inches.	Tons.	Tons.
1 Early Minnesota Sugar Cane	94	.55	16 84
2 Orange Sugar Cane	79	.13	15.64
3 Fodder Cane	84	.57	15.51
4 Early Amber Sugar Cane	90	.38	14 82
5 Kansas Orange Sugar Cane	75	.11	14 23
6 Kaffir Corn	56	.27	11.22
7 Black Rice Corn	58	.27	11 05
8 California Golden Broom Corn	93	1.04	10.44
9 Improved Evergreen Broom Corn	99	.96	9.14
10 Brown Dhoura Corn	60	.56	7.60
11 Early Japanese Broom Corn	92	.90	7.55
12 Yellow Millo Maize	62	.32	7.40
13 Jerusalem Corn	57	.40	6.49
14 White Millo Maize	58	.02	6.18
15 Dwarf Broom Corn	74	.79	7.41

From the accompanying table of results, it will be seen that the Sugar Canes come at the top of the list in total yield of green crop per acre. The Early Minnesota variety produced an average of 16.8 tons, which is about two tons per acre more than that produced by the Early Amber, which is perhaps the best known of the different varieties of Sugar Cane which have been grown in Ontario. The Jerusalem Corn and two varieties of Millo Maize, regarding which extravagant claims have been made, have produced the lightest average yields per acre.

Varieties of Sunflowers.

We have grown in all about a dozen varieties of sunflowers in the experimental department, and have found that nearly all of them have grown satisfactorily. Three varieties have now been grown under similar conditions for eight years in succession

with the following average yields per acre : Black Giant, 18.3 tons of total crop and 5.5 tons of heads; Mammoth Russian, 15.2 tons of total crop and 5.1 tons of heads; and White Beauty, 15 tons of total crop and 5.5 tons of heads. The Black Giant grew to an average height of 94.5 inches, the Mammoth Russian, 90.2 inches; and the White Beauty, 81.4 inches.

Varieties of Millet for Green Fodder and for Hay.

Upwards of thirty varieties of millet have been grown in the experimental grounds at the College for the purpose of gaining information regarding the most suitable kinds for cultivation in this Province. The varieties which have produced the greatest yield per acre in the results of experiments covering a series of years are as follows: Golden Wonder, Holy Terror Gold Mine, Magic, Japanese Panicle, Japanese Barnyard, German or Golden, and Siberian. The Japanese Panicle millet has an upright tall growth, a spreading head, a large amount of leaf, and an abundance of seed. The seeds are comparatively large, nearly black, and very shiny. This variety will likely be grown more extensively, as its good qualities become better known. It usually yields considerably more than the Common Hungarian Grass.

Varieties of Rape, Kale, Cabbage, etc.

Rape is fairly well known in many parts of the Province as a very satisfactory crop to grow, especially for sheep and hogs. The different kinds of cabbage and kale, however, which are used somewhat extensively in Great Britain as a food for farm stock, are not known, except to a very slight extent in Ontario. Experiments have been conducted in each of the past five years with fifteen varieties of rape, kale, cabbage, etc., in order to glean some information regarding the comparative yields of these varieties when grown under uniform conditions in Ontario. The seed has been sown in rows about 26 inches apart, and the land has been cultivated in much the same way as that containing a crop of turnips. Only about one pound of seed per acre is required when sown in rows and the land cultivated. The seeding usually takes place in June, and the crop is harvested in the latter part of September, or in October. The following gives the average results of each variety for five years :

Sutton's Earliest Drumhead Cabbage	18.9 tons per acre.
Dwarf Essex Rape	17.9 tons per acre.
Dwarf Victoria Rape	17.9 tons per acre.
Thousand Headed Kale	16.7 tons per acre.
Purple Sprouting Boroccoli	16.2 tons per acre.
Marrow Stem Kale	16.0 tons per acre.
Hardy Curled Kale	15.6 tons per acre.
Jersey Kale	14.7 tons per acre.
Sutton's Earliest Sheepfold Cabbage	14.5 tons per acre.
Marrow Collards	14.4 tons per acre.
Sutton's Best of All Savoy Cabbage	14.3 tons per acre.
Tall Green Curled Scotch Kale	12.0 tons per acre.
Sutton's Latest Drumhead Cabbage	11.1 tons per acre.
Brussels Sprouts	10.9 tons per acre.
Tall Jersey Cabbage	8.8 tons per acre.

The Buckbee's Wonderful Dwarf Bonanza rape, which has been grown in our experimental plots for only two years, has slightly surpassed the Dwarf Essex variety of rape in experiments of each of the years 1902 and 1903. Through the kindness of Mr. Dicks, of the Cooper-Taber Seed Company, England, we received five other varieties

of rape which we had under experiment in 1903, two varieties of which gave very satisfactory results, namely, the Large Seeded Common Rape and the Large Seeded Umbrella Rape.

Green Fodder Crops.

For three years in succession, fifteen varieties of fodder crops have been grown in competition in the experimental grounds. Some of these varieties have been grown for a very much longer period, but for the sake of comparison the results which are here presented are the averages of the three years 1901, 1902, and 1903 :

Varieties.	Average for three years.	
	Length of plants.	Tons of green crop per acre.
1 Hairy Vetches	33	11.95
2 Medium Green Soy Beans	32	11.50
3 Common Vetches	....	9.80
4 Early Yellow Soy Beans	26	8.65
5 Grass Peas	40	7.18
6 Horse Beans	30	7 13
7 American Coffee Berry	24	6.55
8 Wonderful Cow Peas	17	5.69
9 Extra Early Blackeye Cow Peas	16	5.65
10 Taylor Cow Peas	13	5.27
11 New Era Cow Peas	14	4.87
12 Whip-poor-will Cow Peas	14	4.65
13 Warren's Extra Early Cow Peas	13	3.70
14 Velvet Beans	14	2 30
15 Extra Early Dwarf Soy Beans	19	2.16

In the average results for the past seven years, the Hairy Vetches produced a yield of about 4½ tons of green crop per acre more than that produced by the Common Vetches. The Medium Green Soy Beans, which come second in the accompanying list in yield per acre, are an exceptionally fine variety, and we believe will be grown more and more for the production of fodder either for feeding in the autumn or for mixing with corn when filling the silo, in order to increase the quality of the silage. If the Medium Green Soy beans are sown in rows about 30 inches apart with the beans about 8 inches apart in the row, about the time that the corn is planted, the crop would generally be ready for mixing with the corn and putting in the silo when the corn is in the best condition. The Early Yellow Soy beans are more specially adapted to the production of grain than of green fodder, as they are earlier in maturing than the Medium Green variety and produce a grain which is exceedingly rich, being richer than any of the crops usually grown on Ontario farms. The Grass peas have given very good results as a green crop in each of the past two years, but, owing to the exceptionally cool, damp weather in 1902 and again in 1903, the Grass peas have not ripened as satisfactorily as usual. Most of the varieties of Cow Peas come towards the end of the list in comparative yields of green fodder, and are generally unsuitable for Ontario conditions.

Annual Crops for Fodder Purposes.

An experiment was started in the spring of 1900 to find out which annual crops were likely to give the best results when used for pasture. For this purpose, eighteen crops were selected. In each of the years the crops were sown in three separate sets, there being eighteen plots in each set,—thus making in all a total of fifty-four plots each season. All of the plots were sown on the same day and under similar conditions,

each year. The main object of the experiment was to find out the relative value of the different crops for pasture, both early in the season and throughout the summer. The seed was all sown early in May in each year. The three sets were handled in each season as follows:

Set 1. The crops on all the plots in Set 1 were cut at the end of six, nine, twelve, fifteen, and eighteen weeks after the seed was sown, thus making five cuttings for each crop. Each cutting was weighed in the green state, and also after it was dried in the form of hay.

Set. 2. Each crop was cut when it was thought to contain the largest bulk of the best quality of green fodder. In order to ascertain the aftergrowth, another cutting was also made from each plot later in the season.

Set 3. A hurdle fence was placed around the set of eighteen plots and cattle were turned on the plots daily until the pasture was all eaten. The first pasturing took place the latter part of June and the early part of July. Careful notes were taken of the amount eaten from each crop each day. After the crops were pastured the first time, they were allowed to remain undisturbed until the autumn, when the cattle were again turned on and the second growth was eaten off.

The results of experiments conducted for three years in succession show that the greatest amount of pasture was produced by the following crops: (1) Hairy Vetches, (2) Crimson Clover, (3) Siberian Oats, (4) Early Amber Sugar Cane, (5) Common Red Clover, (6) Common Vetches, (7) Spring Rye, (8) Dwarf Essex Rape, (9) Hungarian Grass, and (10) Mandscheuri Barley.

The results of these experiments up to the present time seem to show the advantage of growing a mixture of annual crops rather than growing the crops separately for pasture. The results indicate that the following combinations should prove serviceable for the production of pasture of good quality throughout the season: (1) Oats, Hairy Vetches, and Early Amber Sugar Cane; (2) Spring Rye, Hairy Vetches, and Hungarian Grass; and (3) Barley, Crimson Clover, and Early Amber Sugar Cane.

In 1903, an experiment was conducted with two mixtures, one of which was thought to be especially suitable as a pasture for cattle, and the other as a pasture for hogs. The mixture for cattle pasture comprised Oats, Hairy Vetches, and Crimson Clover. The crop was cut twice during the season, and produced a total of 23.5 tons of green crop per acre. The mixture for hog pasture comprised Hairy Vetches, Common Vetches, and Rape, and was cut twice during the season, producing a total yield of 20.9 tons of green crop per acre.

Grasses and Clovers for Pasture.

Some very interesting experiments have been started to determine the relative amount of pasture produced by different varieties of grasses and clovers throughout the summer season. These experiments have not been completed, and the results will be held until some future occasion.

Mixtures of Grasses and Clovers for Hay Production.

An experiment was conducted with twenty-one mixtures of grasses and clovers from 1897 to 1899, and was repeated from 1898 to 1900, and again from 1901 to 1903. The experiment was conducted in duplicate from 1901 to 1903. We, therefore, have the average results of four distinct tests, each running for a period of three years. The grass mixtures were sown with a grain crop in every case. The yields of hay produced from each plot in the second and third years of the experiment were carefully determined. Most crops produced two, and a few produced three cuttings in each season. Four different clovers and four different grasses were used. There were sixteen mixtures with one clover and one grass in each mixture, four with two clovers and two grasses in in each mixture, and one mixture was composed of four clovers and four grasses in

combination. The average results of each of the sixteen mixtures having two varieties in each mixture are here presented. It will be understood that these results show the average of four distinct tests made within the last seven years :

Mixtures of Grasses and Clovers for Hay Production.

Mixtures.	Average number of tons of Hay per acre for each cutting. Four experiments each three years, no cutting first year, three cuttings in each of the other two years, making in all 24 cuttings.						Tons of Hay per acre for each year.		
	2nd year.			3rd year.					
	1st cutting.	2nd cutting.	3rd cutting.	1st cutting.	2nd cutting.	3rd cutting.	2nd year, 4 tests, 12 cuttings.	3rd year, 4 tests, 12 cuttings.	Average 2nd & 3rd years, 4 tests, 24 cuttings.
Lucerne, Tall Oat	2.50	1.56	.31	2.54	1.33	.58	4.37	4.45	4.41
Lucerne, Timothy	2 48	1.35	.20	2.61	.90	.45	4 03	3.96	4.00
Lucerne, Orchard	2.33	1.52	.24	2.09	1.03	.47	4 09	3.59	3.84
Lucerne, Tall Fescue....	2.04	1.33	.22	2.14	1.28	.54	3.59	3 96	3.78
Mammoth, Tall Oat	2.98	1.62	.....	2.05	.50	.....	4.60	2 55	3.58
Mammoth, Timothy....	2.86	1.62	.....	2 22	.33	.....	4.48	2.55	3.52
Mammoth, Tall Fescue .	2.75	1.81	.....	1.85	.45	.....	4.56	2.30	3.43
Common Red, Tall Oat.	2 46	1.65	.....	1.95	.71	.....	4 11	2.66	3.39
Common Red, Timothy.	2.25	1.42	.....	2.18	.54	.....	3.67	2.72	3.20
Mammoth, Orchard	2.63	1.73	.....	1.50	.40	.....	4 36	1.90	3.13
Common Red, Tall Fescue	2 08	1.52	.....	1.92	.69	.....	3 60	2.61	3.11
Alsike, Tall Oat	2 60	1.36	.....	1.88	.26	.....	3 96	2.14	3.05
Common Red, Orchard..	2.34	1.50	.....	1.36	.54	.....	3.84	1.90	2.87
Alsike, Orchard	2.28	1.42	.....	1.55	.30	.....	3 70	1.85	2.78
Alsike, Tall Fescue.....	2.31	1.05	.....	2 01	.18	.....	3.36	2.19	2.78
Alsike, Timothy.....	2.14	.89	.....	2.13	.07	.....	3 03	2.20	2.62
Average.....	2 44	1.46	.06	2 00	.59	.13	3.96	2.72	3.34

The average annual production of hay per acre from all the different mixtures included in the experiment under consideration was 3 1-3 tons. The average yield of hay in the second year after the seed was sown was 4 tons, and in the third year, 2.7 tons per acre. It will be seen that the Lucerne and the Tall Oat Grass gave 4.4 tons, being the greatest average yield of hay per acre. The mixture of Lucerne and Tall Oat Grass furnished three cuttings each year. They both start early in the spring, are ready to cut about the same time, and produce excellent aftergrowth. The Orchard Grass is undoubt dly somewhat lower in yield than it would have been had it not become slightly winnter killed in two out of the four tests. This, however, seems to indicate that the Orchard Grass is not quite as hardy as the three other varieties of grasses, included in this experiment.

Mixtures of Hardy Grasses and Clovers for the Production of Either Hay or Pasture.

A large amount of experimental work has been done in testing varieties of grasses and clovers, both singly and in combination, within the past twenty-seven years. The grasses and clovers have been carefully studied, and much information has been gleaned in regard to their value for hay and also for pasture. In 1885, Prof. Wm. Brown, who was then Farm Superintendent at the Ontario Agricultural College, recommended a mixture which he thought well adapted for permanent pasture. Only the most hardy varieties which had been tested up to that time were included in the mixture. In 1893, after eight years additional experimental work, during which time the writer was closely connected with the work of the Experimental Department, another mixture was recommended, containing a smaller number of varieties and requiring a smaller amount of seed per acre. The grasses and clovers recommended in 1893 have proven themselves to be a valuable mixture. They are all hardy varieties, and when grown to-

gether give a large yield. An experiment was started in the spring of 1894 by sowing a plot of the mixture which was recommended in 1885, and a plot of the mixture which was recommended in 1893. The seed was sown with a light seeding of barley; and the germination of the seed of the grasses and clovers was quite satisfactory.

Mixtures of Grasses and Clovers.

Mixture recommended in	Grasses and Clovers.	Varieties in mixtures.	Amount of seed per acre.	Average height of 1st cutting for 9 years.	Yield of Hay per acre.	
					1903 2 cuttings.	Average for 9 years, 21 cuttings.
1885	Grasses	Meadow Fescue	6	32 3	3.44	4 47
	"	Meadow Foxtail	3			
	"	English Rye	2			
	"	Timothy	3			
	"	Canadian Blue	4			
	"	Orchard	3			
	"	Red Top	2			
	"	Yellow Oat	2			
	Clovers	Lucerne	4			
	"	White	2			
	"	Alsike	2			
	"	Red	1			
	"	Yellow	1			
			35			
1893	Grasses	Orchard	4	36.4	4 28	5.14
	"	Meadow Fescue	4			
	"	Tall Oat	3			
	"	Timothy	2			
	"	Meadow Foxtail	2			
	Clovers	Lucerne	5			
	"	Alsike	2			
	"	White or Dutch	1			
	"	Yellow or Trefoil	1			
			24			

Two cuttings were made from each plot in 1895, and from two to three cuttings have been secured in each of the years since that date. In 1903, which is the tenth year since the plots were sown, two cuttings were taken from each plot. The total yield of hay produced from the two cuttings was 4.3 tons from the mixture recommended in 1893, and 3.4 tons from the mixture recommended in 1885. The figures represented in this report show the comparative yields of hay from the two mixtures. They also show that the grasses used for the mixtures are very suitable for the climate of Ontario. These mixtures can be used for the production of either hay or pasture, but are more suitable for pasture purposes, owing to the unevenness in the maturity of the different varieties, which is a detriment to hay production, but an advantage when the crop is used for pasture purposes. Without a single exception, the mixture which was recommended in 1893 has produced a larger yield per acre than that which was recommended in 1885. We have named all the varieties of grasses and clovers sown in each mixture, and also the quantity of seed per acre, particularly for two reasons. In the first place, that this experiment might thus be as clear as possible, and in the second place, that any person wishing to know the quantity of seed per acre of the different varieties which are recommended as a permanent pasture mixture could find the information in good form. It will be observed that the mixture recommended in 1893 possessed none but very hardy grasses and clovers, which have been tested at the College more or less for about twenty-five years. This mixture could, of course, be somewhat modified to suit different localities and different soils.

ACKNOWLEDGMENTS.

I wish to acknowledge the valuable services rendered during the past year by my foreman, Mr. A. E. Whiteside, in looking after the details of work of the department; by my assistant, Mr. W. J. Squirrell, in the office work; by Mr. J. Buchanan, B.S.A., in the work of plant breeding, and by Mr. L. H. Newman, B.S.A., in assisting with the farmers' excursions which came to the College in the month of June.

I wish to thank both yourself and the Minister of Agriculture for the kindly support given me in the work of the Experimental Department during the past year.

Respectfully submitted,

C. A. ZAVITZ,
Experimentalist.

PART XIV.

THE MANAGER OF THE POULTRY DEPARTMENT.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to present herewith the report of the Poultry Department for the year 1903 :

The usual course of lectures was given to the regular College students and the Farm Dairy class.

The attendance at the Short Course in Poultry Raising was not so large this year as the previous year, but was plenty large enough to do satisfactory work. When the class is small, much more satisfactory instruction can be given, especially in practical work.

Special lectures in the Short Course were given by Wm. McNeil, London; J. E. Meyer, Gourock; W. J. Bell, Angus; L. H. Baldwin, Deer Park; and A. W. Tyson, Guelph.

The increasing interest taken by farmers in poultry raising, as was noted in last year's report, has been well sustained throughout the year. Eggs and dressed poultry have brought good prices, the increase in prices being most noticeable in the local markets. The community at large appears to be consuming more eggs and poultry; and this stimulates our home markets, which is what we want.

This has been a more satisfactory year in every respect than any other since I have been in charge of the Poultry Department. Our birds have done better as regards egg production, and the young stock raised has been of a better quality than in previous years. This is quite encouraging. I hope in the next few years to have a larger number of first-class birds of the various breeds as regards both exhibition and utility points. We have such birds now, but not so many as we hope to have in the near future.

Hatching Eggs in January.

We set about 1,000 eggs during the month of January. The eggs this year were better than in 1901. A larger percentage of them were fertile, and, as might be expected, a larger number of good strong chicks were hatched. It took about three and one-half eggs, on an average, to produce a chicken. Later in the year it did not take over half as many; for, as a rule, eggs that are laid in cold weather are not extra good for hatching. It is encouraging to find that as we give the birds more fresh air and exercise, together with plenty of wholesome food, the strength of the germs increase, which gives us a chicken that is easier and more profitable to raise. As yet, I would not care to advise any one to go extensively into broiler raising in Ontario, especially when eggs are selling at 25 cents a dozen or better. With a lower price for eggs, there may be fair reasons to venture, if one has buildings suitable for the work.

Later Hatching.

We used both the hens and the machines for hatching eggs in the natural season. Many of the chickens we hatch at this season of the year are from eggs laid by hens,

having some characteristic we wish to perpetuate. We find it more convenient to hatch such eggs under hens than in machines, as the chicks are more easily marked and distinguished when hatched in this way. Usually the setting is made of eggs from two or more individual hens, representing different varieties. It is always well to set the eggs while they are fresh; and by following the above plan, we can usually manage to have the eggs set before they are ten days old. We use a common leather punch for marking the chicks. The web between the toes is punched usually when the chicks are three days old. These holes seldom grow up ; and they enable us to determine a chicken's breeding at any stage in its life.

Experiments with Incubators.

This is the first year that we have done any work along this line. We have not accomplished very much, but we have secured a good deal of data that can be used in 1904, from which data we hope to reach some conclusions that will be of use to poultry raisers.

During the term of the Poultry School class, the eggs in a 120-egg incubator were divided into three lots : 50 per cent. of the eggs were laid in the tray on their side, which is the usual plan; 25 per cent. were placed with the small end up, and 25 per cent. with the large end up. The 44 fertile eggs placed in the ordinary way hatched 27 chickens ; the 25 fertile eggs placed with the large end up hatched 10 chickens; and the 25 fertile eggs with the small end up hatched 7 chickens, two of which were cripples.

The results of this trial appear to indicate that eggs for incubation should lie in the natural way, that is, on their sides. Some incubator operators are not particular about this in the management of their machines ; and the result is a considerable number of chickens dead in the shell, which is specially noticeable in eggs placed with the small end up.

Experiments were also conducted with oxygen gas. It has been claimed by some authorities that by introducing oxygen gas into the hatching chamber, every fertile egg can be hatched. We tried introducing the gas direct into the chamber and by passing it into the machine with the hot air, after which it diffused through the diaphragm to the eggs.

We encountered several difficulties in this experiment, the most serious of which was to get a constant supply of gas without using more than was thought necessary. In the first trial, conducted in January, about two quarts of gas was forced from a gasometer into a 120-egg machine, each day after the fifth day of incubation. No gas was put in after the eggs chipped. The results of this trial were very poor. A machine of the same make, filled with as nearly as possible the same kind of eggs, hatched considerably better. The oxygen machine hatched 27 chickens from 89 fertile eggs, while the machine run in the ordinary manner hatched 44 chickens from 94 fertile eggs; and practically every chick was killed and sold from the machine run in the ordinary way, while those hatched from the oxygen machine all died, but one or two,—many died during the first ten days of their lives. The chicks were all placed in the same brooder, and fed exactly the same.

It was noticed at the first test of the eggs, on the eighth day of incubation, that some of them showed what is known as the "blood ring," that is, a ring of blood encircling the embryo. This is always considered a sign of trouble later on. The oxygen appeared to be too much of a stimulant, causing abnormal growth of the germ, which often resulted in the rupturing of the blood vessels of the germ.

Two trials were made later in the season, with less gas at later periods of incubation. These were not so unfavorable as the first trial; yet each trial was characterized by smaller hatches and poorer chicks than were obtained from machines run in the ordinary way.

A Cold House.

In November, 1902, it was decided to put some fowls into a cheap, cool, airy house and test their egg production. An exact account of the feed was kept and the results carefully tabulated, as shown below.

The house selected was one of the old colony houses, which are 14 feet long and 10 feet wide. They are about 5½ feet high at the back and 8 feet at the front or south side. They are built of single-ply boards, and the cracks are battened. The building is not sheeted on the inside, except where the roosts are placed; and there a box-like arrangement was constructed in the following manner: The north or back wall was sheeted with matched lumber, about one-half way across the building. In front of this was built a stand of 2x4 scantling the full length of the sheeting and three feet wide. The bottom of this stand is 2 feet clear of the ground, and the ends of the box are sheeted with matched lumber, thus enclosing the roost coop on all sides, with the exception of the front. The roof extending over the roost coop is also sheeted and the space between the rafters stuffed with straw. The intention was to hang a curtain in front of the roost coop to be let down at night; but this was never put on, as the hens appeared to do well without it. There are two windows about 2 feet square in the front side of the house. A piece of cotton was tacked over one of these, and the window pulled back about half way; the other window was kept closed. The open window gave a constant supply of pure cold air.

This house appeared to be very cold; the water froze very quickly in cold weather; in fact, it often required replenishing four or five times a day. We kept a record of the minimum temperature in the house; and the lowest recorded temperature was 9 degrees above zero. This, of course, was exceptional; but 15 to 24 degrees above was very common.

The flock consisted of 18 hens. Two of them were selected from a farmer's waggon on its way to market,—ten of his culls. This much, however, was in their favor, they were in fairly good feather. The other eight consisted of high-grade Leghorns, Plymouth Rocks, and Wyandottes.

The flocks remained healthy throughout the twelve months, with the exception of one hen, which died of indigestion in March.

In April, two of the hens were allowed to sit and rear chickens. Twenty chickens were raised by the two hens. These chickens were kept in the yard of the old flock, and did not do so well as chickens of the same age that had more or less of a free range; but, notwithstanding this disadvantage, they matured fairly well, and the pullets should lay this winter. The yard surrounding the pen is 150 feet by 40 feet.

The following table shows the feed consumed by both hens and chickens:

Wheat	480	lbs. at	70	cents per bush			$5 60
Corn	335	"	56	"			3 35
Barley	271	"	48	"			2 71
Wheat bran	69	"	85	"	cwt.		58
Shorts	69	"	$1 00		"		69
Corn meal	13	"	1 15		"		15
Oat meal	20	"	1 25		"		25
Clover meal	10	"	1 50		"		15
Stale bread	100	"	1 00		"		1 00
19 beef heads at 10 cents each							1 90
30 lbs. beef scrap at 3 cents per lb							90
2 bags of roots at 15 cents per bag							30
300 lbs. (estimated) skim-milk at 10 cents per cwt.							30
Total							$17 88

No charge is made for grit, as there was an abundance of gravel and soft coal ashes in and around the building. These materials make fairly good grit.

In the following table is given the number of eggs laid each month and the selling price of the same; the price of eggs is taken from the Guelph market:

Month.	No. hens in pen.	Eggs laid.	M. P. per doz.	Amount.
			cents.	$ c.
December	18	167	24	3 34
January	18	149	24	2 99
February	18	167	18	2 51
March	17	281	15	3 51
April	17	269	11	2 46
May	17	191	12	1 91
June	17	184	12	1 84
July	11 (killed and sold 6 hens)	127	15	1 59
August	11	112	15	1 40
September	11	90	18	1 35
October	6 (killed and sold 6 hens)	26	20	43
Total				23 38

Stock sold:

July—6 hens, 25 lbs. at 8 cents per lb	$2 00
August—6 cockerels, 22 lbs. at 9 cents per lb	1 98
October—5 hens 22 " 9 "	1 98
November—1 cockerel, 6 lbs. 7 "	42
Total	$6 38

Total sales	$29 71
Cost of feed	17.83
Profit	$11.88

Note.—The hens were sold dressed weight and the chickens live weight.

This is a fair profit from what might be considered an inferior flock. The hens that were purchased from the farmer might have been two years old or seven years old. The age is not known; but they were considered to have outlived their usefulness.

It will be noticed in the above statement that there is no allowance made for the eggs set. These were taken from our best pen of Wyandottes in our regular houses. These eggs, if sold, would be worth $3.00. They are not charged up against the flock, as I sold one cockerel from this yard for $3.00.

The pen for 1904 consists of 10 White Wyandotte pullets and 8 cross-bred yearling hens.

General Treatment of Breeding Stocks.

Our system in 1903 was much the same as in 1902,—if anything, we aired the houses more freely. The stock in general, has been good health, and the egg production above the average. In fact, we had one pen of Wyandottes this year that made a greater average per hen than any pen of birds since I had charge of the department. They laid a little over 179 eggs from December, 1902, to December, 1903. Some eggs were laid every day in the twelve months.

The fresh air system is not so favorable for winter egg production from Leghorns, Minorcas, etc., as from Wyandottes, Orpingtons, and such like birds. The lighter breeds appear to feel the cold much more.

We have practised to some extent the system of not allowing yearling hens intended for breeders to lay during the winter. The idea is to have the hens in the pink of condition, with plenty of vigor in the spring. I am inclined to favor this plan, and depend largely on April and May pullets for winter layers.

Andalusian Fowls.

I wish to call the attention of all purchasers of eggs from this breed of fowls to the fact that Andalusians do not breed true to color ; that is to say, from a setting of eggs you may expect blue chickens,—the natural color,—and black chickens, and white-and-blue chickens.. Several purchasers of eggs in the past have thought they received eggs of mixed breeds, whereas the different colors in the chicks are natural. I sincerely hope that all intending purchasers will bear this in mind.

Ducks

We had several inquiries as to how much feed a duck would eat from the time it was hatched until it was ready for market, that is, about ten weeks of age. Some farmers doubted if it was more profitable to kill and sell the ducks when first feathered, than to hold them until Christmas.

Fifty-one ducks were taken from an incubator on May 29th and placed in a brooder. There were 29 Pekins, 22 Rouens, and Crosses between the Pekin and Indian Runner ducks. The brooder was heated for the first week only ; as the ducks, after the first two or three days, appeared to be very indifferent as to whether there was any heat or not ; so not over three quarts of oil was used. No charge is made for this, the object being to keep account of the grain and other materials consumed. The young ducks were carefully yarded and an accurate account kept of the feed they consumed, with the exception of grass. They grew more or less in the yard, and the ducks helped themselves. No charge has been made for the grit, because most farmers have an abundance of coarse, sharp sand, or fine gravel, which serves the purpose in the feeding of birds. But, making an estimate, I would say that they consumed about 100 pounds of grit, which would be worth about 75 cents.

During the first week the ducks were fed alternately on bread and milk and on corn meal, shorts, and bran in equal parts, with some grit added in each case. The latter was scalded with boiling water. The second week the ducks were fed the corn, shorts, and bran ration, moistened with milk, and had in addition a small amount of beef scrap. This ration was continued until the ducks were four weeks old, when the bran and beef scrap were left out of the ration. The intention was to use some beef scrap ; but at the time, we were unable to procure any, and it was left out of the ration.

The ducks weighed, when six weeks, old, 171 pounds, or an average of about 3 1-3 pounds each, and had consumed 130 pounds of corn, 130 pounds of shorts, 25 pounds of bran, 14 pounds of stale bread, and 15 pounds of beef scrap.

The grain was figured at the following prices per 100 pounds : Corn, $1.15 ; shorts, $1.00 ; bread, $1.00 ; bran, 90 cents ; beef scrap, $3.25 ; skim-milk, 10 cents.

From the sixth to the eighth week, the ducks consumed 310 pounds of shorts and corn, and an equal amount of milk.

They weighed 239 pounds, or on an average of better than 4 1-2 pounds each.

At nine weeks, they weighed 261 pounds, and during the week had consumed 139 pounds of grain, and an equal amount of milk.

At this age the ducks were ready for market. They were in good feather, and should have been killed. However, we killed only six of the flock and fed the remainder for another week. .

From the ninth to the tenth week the forty-five remaining ducks consumed 130 pounds of grain, and an equal amount of milk. During this week the ducks lost 7 pounds in weight, as they began moulting heavily at the beginning of the week. All but thirteen of the ducks were killed at the end of the tenth week. They were sold f.o.b. Guelph at 12 cents per pound. We found in dressing that the ducks lost about 3-4 pound per pair. The necks were pulled in the same manner as the chickens are killed. Had the ducks been bled, no doubt there would have been a greater

shrinkage. After deducting the cost of grain, bread, beef scrap, and milk only, from the selling price, it leaves a profit of nearly 34 cents on each duck. Had we killed all the ducks at the ninth week, there would have been a profit of 38 cents each.

During the eleventh week the remaining 13 ducks consumed 27 pounds of grain, and an equal amount of milk, and they gained only two pounds in weight.

There was not much gain made by the ducks until after the new feathers had been fairly well grown. In fact, the cost of the feed eaten each week after the ninth amounted to more than the price of pounds of gain made during the week.

From this trial it is very evident that when ducks become well feathered, that this is the most profitable time to sell them; and, secondly, that the growth made after the ninth or tenth week will seldom leave any margin of profit, after deducting the cost of feed.

The keeping of spring ducks for Thanksgiving or Christmas trade, where one has to feed them constantly, is a losing game; but if ducks are sold when they are first ready, there is likely to be a good margin of profit.

As regards the breeds of ducks in this experiment, I may say that the Pekins and crosses between the Indian Runner and Pekin matured the fastest. They were ready to kill fully one week in advance of the Rouens.

Experiment in Fattening Chickens.

The following tables give the results of the experiment in fattening:

How fed.	Ration.	No. of birds.	Weight at beginning of experiment.	Pounds of gain in two weeks.	Pounds of grain consumed.	Cost of grain.	Lbs. of grain to make 1 lb. gain.	Lbs. of milk consumed.	Cost of milk 10c. cwt.	Pounds of skim-milk substitute.	Cost.	Total cost.	Cost of one pound gain.
													cts.
Fed in crates..	Grain and milk....	12	40.	15.	43.50	54.37	2.9	65	6.5	.....	.....	60 87	4.
"	....	12	37.75	15.25	37 75	46 87	2 4	55	5.5	... ..	....	52.37	3.4
"	....	12	52.	15.	45.37	56.7	3.02	68	6.8	.....	.....	63.5	4.2
	Average.....	..	.....	15.08	42.20	52.64	2.77	62.6	6.26	.....	.....	58.91	3.9
Fed in loose pen	Grain and milk	12	51	14	45.37	56.7	3.24	68	6.8	.....	.....	63.5	4.5
"	....	12	40.5	15	48.50	54.37	2.9	65	6.5	.....	.....	60.87	4
	Average	..	.....	14.5	44.43	55.5	3.07	66.5	6.65	.....	.....	62.18	4.25
Fed in crates..	Grain and tankage	12	36	16	35.25	44	2.2	....	....	7.50	15	59	3.62
"		12	49	14	35	43.75	2.5	...	....	6.81	13.63	57.38	4.09
	Average.....	.	.....	15	35.12	43.87	2.35	....	....	7.15	14.31	58.19	3.85
	Grain and blood meal	12	54	10	34.62	43.33	3.45	....	....	6.81	18.76	62.08	6.2
	"	12	48	12.5	36.37	45.5	2.9	....	....	4.25	11.68	57.18	4.57
	"	12	37.5	12	35.25	44	2.9	....	....	5	13.68	57.68	4.8
	Average.....	..	.....	11.5	35.41	44.27	3.08	....	....	5.35	14.7	58.98	5.19
Fed in crates	Grain and Morgan's animal meal....	12	52.5	16.5	41.12	51 40	4.49	....	....	8.7	21.75	73.15	4.4
"	Grain & beef scrap.	12	35	15	34.50	43	2.3	....	....	7.3	23.66	66.6	4.4
"	Grain, milk & animal meal	12	53	14	37.25	46.56	2 66	56	5.6	8.12	20 31	72.47	5.17
"	"	12	53	18	42.8	53.5	2.36	64	6.4	3.5	8.75	68.65	3.8
	Average.....	..	.....	16	40	50	2.51	60	6	5.81	14.53	70.56	4.48
"	Potatoes, shorts & milk	12	56	9	31	31	3.4	47	4.7	31	16	51.7	5 7
Fed in loose pen	Potatoes, shorts & milk	12	54.5	10.5	31.12	31.12	2 95	47	4.7	31.12	16	51.8	4.9

This year we have followed along much the same lines as last year. We have tried several substitutes for skim-milk in the fattening ration; and there are one or two which, from this season's trials, appear to be commendable.

The results of the experiments in "pen feeding" versus "crate feeding," are different from anything we have had hitherto; but the difference is largely accounted for by the fact that we succeeded last year in getting the birds in the pens to eat as much as the birds in the crates. In fact, the ate practically the same amount for the period of feeding, although some days one lot ate slightly more than the other.

The pens in which the chickens were fed were 7 ft. by 12 ft., and were well lighted. Twelve chickens were placed in each pen; the chickens were allowed no range out of doors, and very careful attention was given to see that they were not over-fed during the first week. This is very important in either crate or pen feeding.

The grain ration fed consisted of 2 parts finely ground oats, 2 parts of finely ground buckwheat, and 1 part of finely ground corn. This ration cost $1.25 per 100 pounds; the skim-milk cost 10 cents per 100 pounds, and the beef scrap used cost $3.25 per 100 pounds; but in ton lots the latter could be purchased much cheaper. We figured the blood meal and tankage at more than they actually cost, as we were able to get them wholesale. We have charged $2.75 per 100 pounds for the blood meal, and $2 per 100 pounds for the tankage. At these prices there would be a good margin of profit for a dealer. Our reason for charging more than they actually cost us, is that many persons would be obliged to pay these prices; and furthermore, the other animal foods used were purchased at dealers' prices. We have charged $2.50 per 100 pounds for Morgan's animal meal The potatoes cost 45 cents a bag, or 50 cents per 100 pounds, and the shorts $1 per 100 pounds.

The crate-fed birds made a pound of gain cheaper than the birds fed in pens; but if we deduct the second trial in crate-feeding, then the cost of a pound of gain is about equal.

The chickens fed on the potato ration did better in the pens.

It is evident from these trials that good growthy chickens, weighing a little more than three pounds each, are more profitable feeders than larger birds.

Of the different substitutes used for skim-milk, I would recommend "Digester Tankage," sold by Swift & Co., of Chicago, and A. J. Morgan's "Animal Meal," which can be obtained from his office in London.

"Blood Meal" did not give nearly so good returns; and furthermore, these rations were not relished by the chickens.

"Beef Scrap" gave very good returns; but at sixty to seventy dollars per ton, it is too expensive.

The potato and shorts ration is only a fair one, but no doubt would be very convenient for many farmers; and where the market demands a half-fat chicken, this ration is worthy of consideration.

The feeding of both animal meal and skim-milk does not appear to have any particular advantage over the feeding of either one singly with the grain ration.

I wish to thank both yourself and the Minister of Agriculture for the assistance that you have given me in many ways.

Respectfully submitted.

W. R. GRAHAM.
Manager of Poultry Department.

PART XV.

THE LECTURER ON APICULTURE.

To the President of the Ontario Agricultural College :

Sir,—I have the honor to present herewith my report on the work in the Department of Apiculture.

The usual course of eighteen lectures was given in the fall term to the first year, and as the weather was very warm, I was able to make frequent use of bees in practical demonstration.

Storing Honey for Granulation.

In the United States, great use has been made of paper bags coated over with paraffin wax for the purpose of storing honey in them. When the honey has granulated the paper is torn off, and the lumps of granulated honey are ready for market. This plan has several defects : the bags can be used but once ; if the bags are small, the amount of wax required per ton of honey is very great ; and this year sufficient bags could not be procured.

This year I built a tank six feet long, three feet wide, and two feet deep. The material was ordinary flooring, the dressed side being used for the inside of the tank. The sides, ends, and bottom were each a separate section, i.e., the flooring was held together by cross pieces, so that each section (either bottom, side, or end) looked like a barn door. The tank is held together by four clamps, of which only one is shown in Fig. 1 (p. 160). The clamps are made of two by four inch scantling spiked together. The tank is placed within the clamps, which are an inch wider than the tank at each side, and the parts of the tank are held closely together by driving wedges between the sides and the clamps. To prevent the ends from being pressed outwards, cleats are nailed on the sides and bottom. The outside was painted to prevent shrinking and the inside coated over thickly with paraffin wax as a provision against leaking.

When the honey in the tank had granulated, the wedges were removed and the sides and ends taken away, and a solid cake of granulated honey, weighing a ton, was left. The cake was divided into pieces of various sizes by drawing a wire through it, as grocers cut cheese.

Swarming.

The immense labor connected with swarming has, more than anything else, prevented beekeepers, with a few exceptions, from extending their business to a much larger scale. The following different methods of preventing swarming were tried :

Three combs of capped brood were lifted out of the brood chamber and placed in the extracting super. Their place was filled by inserting frames filled with full sheets of foundation. This did not retard swarming, and there was the annoyance of having queen cells started in the extracting super, as it is difficult to find brood combs without eggs. In those colonies where the three brood combs were "lifted" earlier in the season, queen cells were not started in the supers; but, so far as could be seen, swarming was not delayed.

The same method was tried with other colonies, with the exception that frames with starters, instead of full sheets of foundation, were placed in the brood chambers. This did not retard swarming in the least, and drone comb was built on the starters. Often swarms issued before very much comb had been built.

Again, swarms both natural and artificial were placed in a dark cellar for two days and then returned to the old hive after the queen cells had been torn out and an empty hive had been placed under the brood chambers. Twenty per cent. of these swarmed out again. It must be taken into account, however, that swarming this last summer (1903) was very severe.

Taylor swarm catchers were provided and a person employed to watch a yard ; and in this way the swarms were caught and were hived by myself in the evening. When two swarms commenced to issue at the same time, cloths were stuffed into the entrance of the hives and the swarms confined there for ten or fifteen minutes without any apparent injury. Then, when the operator was ready, "catchers" were placed in position, the cloths snatched away and the swarms issued into the "catchers." This method worked very well ; but it required a person to watch each yard.

Again wedges were placed between the hive bottom and brood chamber and another pair of wedges between the queen excluder and extracting super, making two very deep entrances for each hive. This retarded swarming, but did not prevent it.

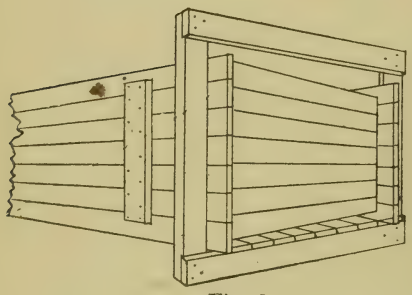


Fig. 1.

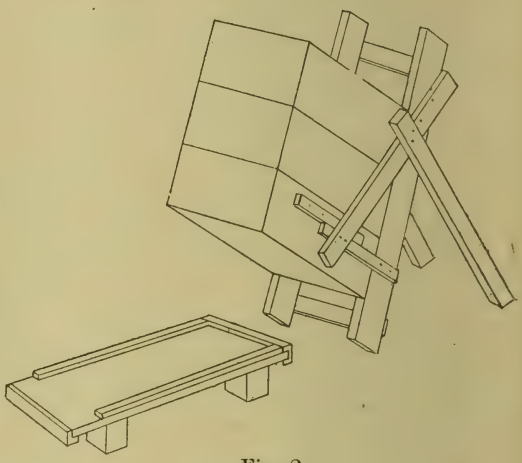


Fig. 2.

"Shaking swarms" was practised ; but to take off each extracting super and the queen excluder and then take out the combs of the brood chamber, to see if queen cells had been started, involved infinite labor; and to do away with this, I made a truck, after the manner of the one shown in the illustration (Fig. 2). The cleat on the truck is slipped underneath the cleat, which is nailed to the hive. The bottom board is pried loose and the truck is tilted backwards until the back legs rest upon the ground. Thus the different parts of the hive are not displaced. By smoking, the brood frames are cleared of bees; and the bottoms of the combs may be easily examined to see if queen cells have been started, the majority of which are built on the bottoms of the combs. If cells are seen, the colony has the swarming impulse and the swarm is "shaken." By using this truck, I searched the hives for queen cells every six days, with very little labor ; "shook swarms" where it was required ; and left the other colonies which were set apart for this experiment, alone for another six days.

In conclusion I may say that I prefer to handle swarms after the last method, to the exclusion of the other expedients herein enumerated.

Respectfully submitted,

H. R. ROWSOME,
Apiarist.

PART XVI.

THE LIBRARIAN.

To the President of the Ontario Agricultural College :

Sir,—As College Librarian, I have pleasure in submitting a brief report for 1903.

Aided by a larger appropriation from the Legislature, we have been able to buy more books during the past year than formerly. 1,125 have been added, compared with 639 of the year 1902. We have purchased back numbers of the following periodicals, which, with the numbers we had on our shelves, complete the sets: Journal of the Royal Microscopical Society, Journal of the Chemical Society, Arboretum and Fruict, Popular Science Monthly, Zeitschrift fuer Hygiene. The Canada Farmer, Zeitschrift fuer pflanzen krankheiten, Le Naturaliste Canadien, Saccardo' Sylloge Fungorum, Berlese Icones Fungorum, Science, Veterinary Journal.

We desire to acknowledge the following gifts from the Education Department, Toronto : Documentary History of Education in Upper Canada, by J. G. Hodgins, Vols. 2-10; also some miscellaneous books on Agriculture. We also wish to express our appreciation of all our exchanges, especially those of the United States Department of Agriculture and various Experiment Stations in America, India, Australia and Europe.

The 1,125 books added to the Library during the year are classified as follows :

Agriculture (including 31 bound periodicals)	80	Physics	41
Agricultural Reports	110	Entomology	25
Horticultural Reports	18	Chemistry (including 88 periodicals)	109
Botany	57	Veterinary Science	35
Geological Reports	7	Domestic Science	11
Nature Study	7	English Literature	45
General Science	85	Economics	14
Horticulture (including 13 bound periodicals)	44	Hygiene	51
Dairying	22	Entomology Reports	5
Geology	6	Zoology	27
Poultry	7	Bacteriology (including 12 bound periodicals)	30
Biology	12	Forestry	11
Science Reports	46	Technology	25

The number of books bound was 369.

The Library received by purchase, or exchange, 150 periodicals, most of them bearing on agriculture.

The total number of bound books on our shelves is 11,146, and between four and five thousand pamphlets.

In order to make the publications of the Ontario Department of Agriculture more accessible, so that anyone can quickly look up a given subject, we have commenced to card-index all the publications of the Department. This work will necessarily take considerable time; but some progress has already been made.

The author and subject cards are written for each title, and as much information as possible is placed upon the card, so as to give the person a good idea of the manner in which the indexed article is treated. Miss Rowsome has had this work in charge ; and I desire to place on record my appreciation of her efficient services in the Library during the past year.

Mr. W. T. Milligan has had charge of the book delivery and has rendered satisfactory service.

Respectfully submitted,

F. C. HARRISON,
Librarian.

PART XVII.

THE PHYSICIAN.

To the President of the Ontario Agricultural College :

Sir,—I have the honor of presenting to you my tenth annual report.

As in the past I have made the required inspection of the students at the opening of the College and Dairy School.

On reference to my records I find the usual frequent occurrence of tonsilitis, bronchitis, influenza, digestive disorders, etc., amongst the students during the winter months. We had also one case of acute lobar pneumonia taken to the General Hospital here, where the patient made a good recovery.

In the month of March we were threatened with an outbreak of smallpox. A young man consulted me with regard to an eruption which was determined to be varioloid. He was isolated in the smallpox hospital of this city, and vaccination of all unprotected persons carried out, and other preventive measures put into effect, with the fortunate result that no further spread of the disease took place.

An instance of septic infection occurred, in the foot of one of the students, and, though the case seemed quite serious, the patient made a good recovery.

I regret to report the death of a most promising young man from acute intestinal obstruction, in the month of December, under very sad circumstances.

Among the numerous casualties occurring in the College, I may mention a fracture of the malar bone in a football game as perhaps the most serious received.

On my inspection I found everything about the College in the usual sanitary condition.

Respectfully yours,

W. O. STEWART,
College Physician.

Guelph, Dec. 31st, 1903.

FINANCIAL STATEMENT, 1903.

I. COLLEGE EXPENDITURE.

(a) College Maintenance.

1. *Salaries and Wages*	$29,883 57	
2. *Food* :		
Meat, fish and fowl	6,347 00	
Bread and biscuits	1,182 88	
Groceries, butter and fruit	6,470 69	
3. *Household Expenses* :		
Laundry, soap and cleaning	393 59	
Women servants' wages	2,197 41	
4. *Business Departments* :		
Advertising, printing, postage and stationery	1,788 93	
5. *Miscellaneous* ;		
Maintenance of Chemical Laboratory	644 09	
" Physical "	342 09	
" Biological "	520 73	
" Bacteriological Laboratory	370 56	
Library and reading room,—books, papers, etc	2,047 32	
Scholarships	90 00	
Short courses in Judging	290 82	
*Telephone service, rent and messages ($234.35)	246 45	
School assessment: S.S. No. 7	110 40	
Temporary assistance	473 78	
Travelling expenses	586 42	
Student labor	3,850 31	

(b) Maintenance and Repairs of Government Buildings.

Furniture and furnishings	1,211 89	
Repairs and alterations	2,019 70	
†Fuel	12,620 56	
Light	209 03	
Sewage disposal	462 80	
Museum (birds and insects, Biological Department)	239 35	
J. W. L. Forster, painting, Sir Wm. Macdonald	250 00	
Macdonald Institute (staff, fuel, etc.)	3,482 94	
Unenumerated	806 41	
		$79,139 72

College Revenue.

Fees	4,303 50	
Board accounts	16,043 07	
Supplemental Exams	48 00	
Rent of post office boxes, Sept. 1903 to Sept. 1904	44 00	
Rent of Houses	100 00	
Contingencies	8 66	
Sale of coal to engineer during coal famine	17 67	
Breakages	39 35	
Fines (College)	139 00	
" (Library)	17 30	
Chemical Laboratory (sale of alkaline solution)	158 00	
Analysis of city water	4 00	
Macdonald Institute (fees and tuition)	285 00	
		21,207 55
Net expenditure		$57,932 17

* Telephone service, etc., transferred to Miscellaneous in Audit Office Report to balance.

† A great increase due to the scarcity and exceptional price of coal owing to strike last winter and the addition of the new Massey Hall Library and the Biological and Physical Laboratories, the cold storage ice machine and the new stock pavilion.

Laying in of a supply January, February and March, 1904. This latter is due to the fact that the street railway cannot haul coal during the winter and teaming it from the city costs 20 cents per ton extra.

STUDENT LABOR, 1903.—To Different Departments.

Totals per month.		*Analysis per year.*	
January	$ 344 02	College	$ 113 72
February	312 14	Bacteriological Laboratory	19 90
March	434 16	Physicial "	80 07
April	116 67	Chemical "	97 12
May	294 11	Biological "	24 25
June	177 39	Engineer Dept	21 29
July	150 13	Excursions	50 32
August	116 96	Massey Buildings	5 07
September	335 15	Farm Dept	1,236 92
October	810 03	Experimental Dept	818 37
November	552 52	Dairy Dept	387 08
December	207 03	Dairy School, Cold Storage, etc	8 80
		Poultry Dept	187 64
		Horticultural Dept	576 60
		Mechanical "	220 29
		Macdonald Institute	2 87
	$ 3,850 31		$ 3,850 31

II. FARM EXPENDITURE.

(a) Farm Proper and Experimental Feeding.

1. *Permanent Improvements*		78 13
2. *Maintenance:*		
Wages of foremen and men	3,672 49	
Live stock—Cattle and swine for feeding, etc	4,866 64	
Maintenance of stock	2,049 92	
Seeds	179 30	
Binder twine	72 04	
Repairs, alterations, and blacksmithing	941 97	
Furnishings	31 06	
Tools and implements	282 05	
Advertising, printing, postage, and stationery	289 61	
Fuel and light	19 81	
Experimental feeder	354 00	
*Contingencies	354 66	
Purchase of team	500 00	
		$13,613 55
		13,691 68

*Telephone service transferred to Miscellaneous in Auditor's Report.

Farm Revenue.

1. *Sale of Stock:*		
Cattle, 53 head	3,968 79	
Pigs, 232 head	2,483 46	
Sheep and Lambs, 26 head	182 00	
Old horse	50 00	
Experiment sale,—3 carcasses beef, killed for instruction in short course.	245 43	
Miscellaneous Sales:		
Roots,—turnips, etc	54 75	
Sugar beets	13 67	
Hay	112 50	
Barley for seed	66 10	
Meal	109 50	
Wool	25 38	
Hide	1 80	
Milk	27 75	
Old iron	2 00	
Service of animals	265 00	
		$7,608 13
Net expenditure, allowing nothing for supplies to College, feed for dairy stock, keep of horses for College and other departments		6,083 55

This statement includes only the cash transactions for the year.

(b) Field Experiments.

Experimentalist—salary	$1,800 00
Foreman—salary	600 00
Teamsters—wages	533 00
Laborers—wages	2,425 14
Seeds	333 91
Manure	54 70
Furnishings, repairs, blacksmithing, etc	227 61

(*b*) FIELD EXPERIMENTS.—*Continued.*

Printing, postage, stationery, etc	$ 61 82		
Stenographer	290 00		
Assistant Experimentalist—salary	500 00		
Contingencies	97 85		
Implements	56 83		
Purchase of horse	175 00		
		7,155 86	
Permanent improvements		662 70	
Total expenditure			$7,818 56

III. DAIRY SCHOOL.

EXPENDITURE.

Wages of Instructors		1,737 45	
Engineer		46 50	
Furnishings, repairs and cleaning ; dairy appliances		743 29	
Fuel and light		448 51	
Advertising, printing, postage and stationery		193 29	
Contingencies		128 04	
Milk for use in School		3,668 09	
Travelling expenses		3 50	
*Refrigerator plant (ice machine)		1,222 98	
			8,191 65

REVENUE.

Fees		142 20	
Sales of Butter : 18,455½ lbs. @ from 18c to 23c		4,025 46	
Sales of Cheese : 7,767¼ lbs. @ from 7c to 13c		961 49	
Sales of Skimmilk and Whey		4 55	
Sales of Cream : 8 cts. @ 20c		1 60	
Sales of Milk and Buttermilk : 1,075 qts. @ 4c		43 00	
Sales of Sundries : 3 testers	9 00		
Expenses Prof. Dean	6 00		
		15 00	
			5,193 30
Net expenditure			2,998 35

*Dairy School ice machine, $1,222.98, should not be in the Maintenance Expenditure as it is properly an expenditure on Capital Account.

III. DAIRY DEPARTMENT.

EXPENDITURE.

Foreman (8½ months)		326 10	
Cheesemaker (8½ months)		472 17	
Buttermaker "		328 42	
Cattleman		480 92	
Milk for experiments		8,037 70	
Cows		71 50	
Food and fodder		413 53	
Furnishings and repairs		813 21	
Fuel and light		674 51	
Laboratory expenses, chemicals, etc		107 17	
Contingencies, advertising, printing, postage and stationery		337 24	
Engineer (8½ months)		259 50	
			12,321 9

REVENUE.

Sales of Butter : 33,180½ lbs. @ from 15c to 23c		6,692 68	
Sales of Cheese : 6,442½ lbs. at from 8c to 12c		701 12	
Sales of Milk : 2,474 qts. @ 4c		98 96	
Sales of Skimmilk and Whey		15 08	
Sales of Cream : 62 gal. @ 60c., 1 qt. @ 20c		37 40	
Sales of Fat		89 35	
Sales of Cattle :			
2 bull calves	35 00		
9 grade calves	32 00		
3 cows	122 00		
6 heifers	165 00		
		354 00	
Sale of Treadmill		50 00	
Sale of Rennet		1 10	

DAIRY DEPARTMENT.—*Continued.*

Sale of Separator		$35 00	
Sale of Old Iron		2 00	
Rebate on Ice Machine		14 15	
			$8,090 84
Net expenditure (Allowing nothing for milk or cream supplied to the College)			4,231 13

IV. POULTRY DEPARTMENT.

EXPENDITURE.

Wages of assistant		428 06	
Purchase of stock		53 21	
Furnishings, repairs, etc.		159 67	
Feed, etc		293 27	
Fuel, light and contingencies		283 64	
Experiments in fattening poultry		934 44	
			2,202 29

REVENUE.

Sale of Eggs:			
For hatching—137 sittings	167 40		
For domestic use—688½ doz	114 09		
		281 49	
Sale of Poultry:			
Live birds—224	217 70		
Dressed birds	451 62		
		669 32	
Sale of old bones		1 00	
" *feathers*		1 20	
			953 01
Net expenditure			$1,249 28

Telephone service transferred to Miscellaneous in Auditor's Report.

V. HORTICULTURAL DEPARTMENT.

EXPENDITURE.

Permanent Improvements		748 80	
Maintenance:			
Salary of head gardener and foreman	$749 98		
" assistant " "	600 00		
" " in greenhouses	400 00		
Teamster	390 41		
Wages of laborers	1,893 07		
Manure and fertilizers	74 21		
Seeds, bulbs, plants, trees, etc	209 84		
furnishings, repairs, implements and tools	621 16		
Fuel and light	553 40		
Purchase of horse	190 00		
Contingencies	171 02		
		5,853 09	
			6,601 89

REVENUE.

Sale of 98 baskets strawberries at 5c	4 90		
" *cut greens, etc.*	65		
			5 55
Net expenditure			6,596 34

Ordinarily there is no revenue from this department, as the produce is used by the College.

VI. MECHANICAL DEPARTMENT.

Salary of foreman	$750 00		
Tools, fuel, and light	147 26		
		$ 897 26	

TOTAL NET EXPENDITURE ON MAINTENANCE ACCOUNT: $87,806 64

S. SPRINGER,
Bursar.

INDEX.

Agriculture, Report of Lecturer, 159.
Agriculture, Report of Professor, 77.
Agricultural Education in Canada, vii, ix, x.
Agricultural Schools and Colleges, x.
Agronomy, 113.
Alkaline Solution, 56.
Andalusian Fowls, 156.
Apiculture, Report of Lecturer, 159.
Apples, 91.
Associate Diploma, recipients, xiv.

Bachelors Science of Agriculture, xiv.
Bacteriological Analyses, 97.
Bacteriology, Report of Professor, 96.
Bakers' School, 99.
Barley, 78, 117, 118, 119, 132.
Beans, 118, 135.
Biology, Report of Professor, 17.
Bird Migration, 34.
Black Death, 44.
Blood Meal, 81, 86.
Bracted Plantain, 26.
Bug Death, 45.
Butter-making, 64.

Cabbage, 146.
Carrots, 143.
Cheese Factories, Instruction in, viii.
Cheese-making, 66.
Cheese Ripening Temperatures 54, 66, 70.
Cheese, Tubercle Bacillus in, 100.
Chemistry, Report of Lecturer, 51.
Chemistry, Report of Professor, 37.
Cherries, 93.
Climatic Limits, 4.
Clovers, 148, 149, 150.
Cocoa-shell Milk for Calves, 73.
Cold House for Fowl, 154.
Cold Storage, 14, 64, 71, 94.
College Publications in 1903, xii.
Composition of Rich Soils, 38.
Corn for Fodder or Silage, 79, 144.
Corn for Grain, 134.
Cream Testing, 63.
Creameries, Instruction in, viii.
Cultivation, Methods, 122, 145.
Cumming, M., Report of, 81.
Curd, Cooking Temperatures, 72.
Currants, 94.

Dairy Herd, 75.
Dairy Husbandry, Report of Professor, 60.
Dairy Schools, x, 60.
Dairy Stock, 73.
Day, G. E., Report of, 77.
Dean, H. H., Report of, 60.
Dean of Residence, Report of, 1.
De Coriolis, E. G., article by, 38.
Dominion Experimental Farms, ix.

Ducks, 156.

Egyptian Pea Blight, 26.
Emmer, 117, 127, 130, 131.
English, Report of Lecturer, 2.
Excursions to College, xvi.
Experimental Work, 114.
Experimentalist, Report of, 113.

Fairs, vii.
Farm Crops in Ontario, 115.
Farm Superintendent, Report of, 77.
Farmers, Assistance Offered, 98.
Farmers' Institutes, x.
Fattening Chickens, 157.
Feeds, Experiments with Cut and Uncut, 85.
Feeding Live Stock, 80.
Fertilizers, 42.
Field Agriculture, 113.
Financial Statement, 163.
First-class Men, xv.
Flour, 40.
Flour Mills, Analyses of By-products, 51.
Fodder Crops, 144, 145, 146, 147.
Freezing Point of Fruit Juices, 13.
Fruit, Co-operative Testing, 89.
Fruit, Experiment Stations, ix, 89.
Fruit, Experimental Work at College, 90.
Fruit Growing and Weather Conditions, 6.
Fruit Juices, Freezing Point of, 13.

Gamble, W. P., Report of, 51.
Geology, Report of Professor, 17.
Gooseberries, 94.
Graham, W. R., Report of 152.
Grain, Comparative tests, 116.
Grain, Fodder Crops, 147.
Grain Judging, 120.
Grain Mixtures, for Grain and Straw, 12 .
Grain sown at different dates, 124.
Grasses, 148, 149, 150.

Hairy Vetch, 135.
Harcourt, R., Report of, 37.
Harrison, F. C., Report of, 96, 161.
Hatching, early and late, 152.
Hay, Grasses and Clovers for, 77, 148, 149.
Herbarium, 18.
Honey, Storing for Granulation, 159.
Horse Judging, Special Classes in, 58.
Horticulture, Report of Professor, 88.
Hulless Barley, 117.
Hutt, H. L., Report of, 88.

Incubators, 153.
Injurious Insects, 32.
Insects, 18, 32.
Insecticides, 43, 140.

Japanese Beans, 135.

Kale, 146.
Kno Bug, 44.

Latitude, influence on Grain Seed, 123.
Librarian, Report of, 161.
Lightning, Destruction by, 4.
Live Stock, 59, 79, 80.
Lockhead, W., Report of, 17.

Macdonald Building, xii.
McLean, J. A., Report of, 1.
Mangels, 78, 141, 142.
Milk for Markets, 61.
Millet, 146.
Mills, President James, Report of, vii.
Museum, 20.
Mustard Spraying, 21.

Nature Study Class, 20.

Oat Mills, Analyses of By-products, 51.
Oats, 78, 117, 118, 119, 133.
Orchard Cover Crops, 90.

Parsnips, 144.
Pasture, Grasses and Clovers for, 148, 149.
Pea Mills, Analyses of By-products, 51.
Peas, 117, 118, 119, 134.
Pears, 92.

Pear Tree Psylla, 32.
Physics, instruction in, x.
Physics, Report of Professor, 2.
Physician, Report of, 162.
Plant Breeding, 118.
Plums, 92.
Potatoes, 79, 139.
Potato Beetle, 140.
Potato Blight, 30, 141.
Potato Bug Finish, 44.
Poultry, Report of Manager, 152.
Preservatives for Butter, 55.
President, Report of, vii.
Prizes, xvi.
Public Schools, Agriculture in, ix.
Pulp, Sugar Beet, 49, 74.

Rape, 146.
Raspberries, 93.
Raspberry Cane Blight, 27.
Reed, J. H., Report of, 57.
Rennet, effect on Cheese Ripening, 69.
Reynolds, J. B., Report of, 1.
Rosin Plant, 26.
Rowsome, H. R., Report of, 159.
Rye, 117, 118, 131, 132.

Scholarships, xv.
Seed Germination and Temperature, 9.
Seed Selection, 118.
Skim-milk, 81.
Smut in Oats and Winter Wheat, 122.
Societies, Agricultural, vii.
Soil Temperatures, 11, 12.
Soils, Composition of Rich, 38.
Soja Beans, 45, 135.
Soy Beans, 135.
Spelt, 127, 130, 131.
Spring Barley, 132.
Spring Rye, 117, 132.
Spring Wheat, 117, 118, 119.
Squirrel Tail, or Wild Barley, 25.
Starch Mills, Analyses of By-products, 51.
Steers, Feeding Experiments, 84, 87,
Stewart, Dr. W. O., Report of, 162.
Strawberries, 93.
Students, number, religion, etc., xiii.
Sugar Beets, 74, 135, 139, 142.
Sugar Beet Pulp for Dairy Cows, 74.
Sunflowers, 145.
Swarming of Bees, 159.
Swede Turnips, 143.
Swine, Feeding experiments, 81.

Tankage, 81.
Tomatoes, 94.
Travelling Dairies, viii.
Tubercule Bacillus in Cheese, 100.
Turnips, 143.

Vetches, 117, 135.
Veterinarians, assistance offered, 98.
Veterinary Science, Report of Professor, 57.

Water, Tests for Purity, 56.
Wax Models of Fruit, 95.
Weather Conditions at the College, 115.
Weeds, new, 24.
Wheat, 78, 117, 125.
Wheat and Flour, 40.
Wild Barley, or Squirrel Tail, 25.
Winter Barley, 132.
Winter Rye, 131.
Winter Wheat, 119, 125.

Zavitz, C. A., Report of, 113.

THIRTIETH ANNUAL REPORT

OF THE

Ontario Agricultural College

AND

Experimental Farm

1904

(PUBLISHED BY THE ONTARIO DEPARTMENT OF AGRICULTURE, TORONTO.)

PRINTED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:
Printed by L. K. CAMERON, Printer to the King's Most Excellent Majesty
1904

TORONTO:
WARWICK BRO'S & RUTTER, LIMITED, PRINTERS.

To the Honourable WILLIAM MORTIMER CLARK, K.C.,

Lieutenant-Governor of the Province of Ontario.

MAY IT PLEASE YOUR HONOUR :

I have the pleasure to present herewith for the consideration of your Honour the Report of the Ontario Agricultural College for 1904.

Respectfully submitted,

NELSON MONTEITH,

Minister of Agriculture.

TORONTO, 1905.

The Ontario Agricultural College

AND

Experimental Farm, Guelph, Ont.

HON. NELSON MONTEITH, Minister of Agriculture, Toronto, Ont.

STAFF OF PROFESSORS, LECTURERS AND DEMONSTRATORS, 1905.

G. C. CREELMAN, B.S.A., M.S. ..... President
H. H. DEAN, B.S.A. ..... Professor of Dairy Husbandry
C. A. ZAVITZ, B.S.A. ..... Professor of Field Husbandry and Experimentalist
J. HUGO REED, V.S. ..... Professor of Veterinary Science
G. E. DAY, B.S.A. ..... Professor of Animal Husbandry and Farm Superintendent
H. L. HUTT, B.S.A. ..... Professor of Horticulture
J. B. REYNOLDS, B A ..... Professor of Physics and Lecturer in English
F. C. HARRISON, B.S.A., D.P.H. ..... Professor of Bacteriology
W. LOCHHEAD, B.A., M.S. ..... Professor of Biology and Geology
R. HARCOURT, B.S.A. ..... Professor of Chemistry
W. R. GRAHAM, B.S.A. ..... Manager and Lecturer in Poultry Department
H. R. ROWSOME ..... Lecturer in Apiculture
W. P. GAMBLE, B.S.A. ..... Lecturer in Chemistry
H. S. ARKELL, B.S.A. ..... Lecturer in Agriculture
F. H. REED ..... Dean of Residence and Instructor in English and Mathematics
ALICE ROWSOME, B.A. ..... Assistant in Library and Instructor in French and German
T. D. JARVIS, B.S.A. ..... Lecturer in Biology
V. W. JACKSON, B.A. ..... Demonstrator in Biology
E. G. DE CORIOLIS, B.S.A. ..... Demonstrator in Chemistry
W. H. DAY, B.A. ..... Demonstrator in Physics
H. S. PEART, B.S.A. ..... Demonstrator in Horticulture
B. BARLOW, B.S. ..... Demonstrator in Bacteriology
J. BUCHANAN, B.S.A. ..... Demonstrator in Field Husbandry
CAPTAIN CLARK ..... Instructor in Drill and Gymnastics

Office Staff.

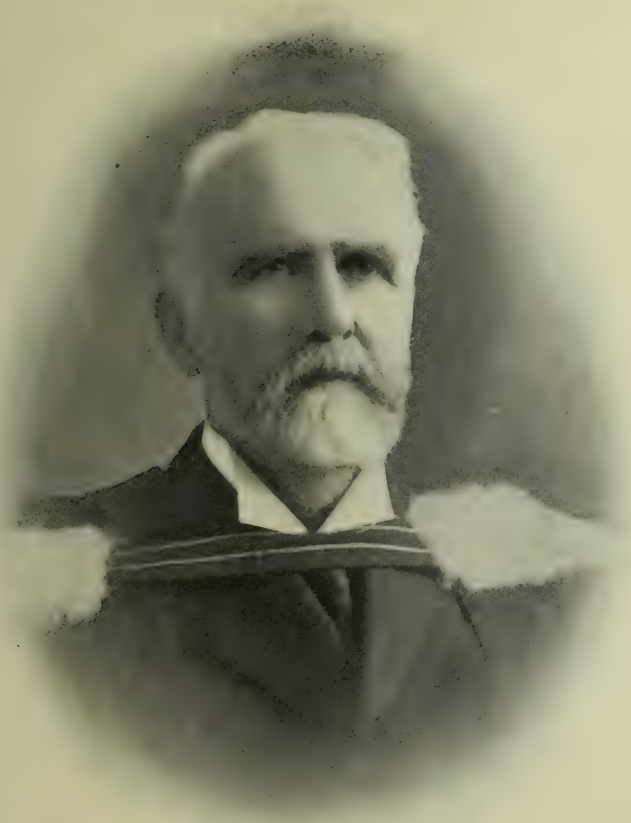
S. SPRINGER ..... Bursar
B. S. PICKETT, B.S.A. ..... Secretary
MISS ANNIE HALLETT ..... Stenographer

Physician.

W. O. STEWART, M.D.

Staff of Instructors, Macdonald Institute.

S. B. MCCREADY, B.A. ..... Professor of Nature Study
MISS M. U. WATSON ..... Lady Principal
JOHN EVANS ..... Macdonald Instructor in Manual Training
MISS HELEN GIVEN ..... Instructor in Domestic Science
MISS HELEN HOLLAND ..... Assistant in Domestic Science
MISS GRACE ROBARTS ..... Instructor in Domestic Art
ANNIE ROSS, M.D. ..... Instructor in Physiology, Home Nursing, and Emergencies



JAMES MILLS, L.L.D.
Ex-President of the Ontario Agricultural College.

The late Dr. W. H. Muldrew, Dean of the Macdonald Institute.

ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM.

FOR THE YEAR 1904.

GUELPH, December 31st, 1904.

To the Honorable the Minister of Agriculture :

SIR,—I have the honor to transmit herewith the Thirtieth Annual Report of the Ontario Agricultural College and Experimental Farm, including the Report of the Macdonald Institute.

The following is a brief review of the work contained in this Report:

THE ONTARIO AGRICULTURAL COLLEGE.

PAGE.

PART I.—REPORT OF THE PRESIDENT 3

Changes in the Staff, 3; The late Dr. Muldrew, 4; Attendance, 4; Macdonald Hall, 4; Consolidated Rural School, 4; College Work and Progress, 5; The Matron, 5; Short Courses, 6; Farmers' Institutes' Excursions to College, 6; Needs of the College, 6; Students of the College, 7; Analysis of College Roll, 7; Bachelors of the Science of Agriculture, 8; Recipients of Associate Diplomas, 8; First Class Men, 9; Scholarships, 10; Prizes, 10; Professional Dairy School Certificates, 10; Financial Statement, 1904, 12.

PART II.—REPORT OF THE DEAN OF RESIDENCE 17

PART III.—REPORT OF THE PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH 19

Instruction in English, 19; Instruction in Physics, 20; Additional Lecture Courses, 22; Correspondence, Articles and Bulletins, 22; Outside Work, 22; Lightning Report, 23; The Shipping of Fruit to Winnipeg by Freight, 25; Some Notes on Dimensions of Packages in Relation to Cooling, 29; Observations at American Colleges, 30; Weather Report, 1904, 32; Investigations, 33.

PART IV.—REPORT OF THE PROFESSOR OF BIOLOGY AND GEOLOGY 35

Instruction, 35; Outside Work, 37; Report of Mr. T. D. Jarvis, Lecturer in Biology, 38; Weed Spraying, 39; Insects and Fungus Diseases, 40; A Key to Fungus Diseases of the Apple, 43; A Key to Fungus Diseases of the Peach, 43; A Key to Fungus Diseases of Brambles, 44; A Key to the Fungus of the Groselles, 45; A Key to the Fungus Diseases of the Grape, 45; Apple Tree Cankers, 48; Sun Scald and Frost Canker, 48; Nectria Canker, 48; Bitter Rot Canker, 49; Black Rot Canker, 49.

PART V.—REPORT OF THE PROFESSOR OF CHEMISTRY 50

Teaching, 50; Miscellaneous Work, 51; Investigation Work: Tests of different varieties of Sugar Beets, 51; The Sugar Beet Industry, 54; Wheat and Flour, 54; Report of the Columbus Laboratories, 57; Preston, Stanley, and Percy Wheats, 58; Quality of Flour from Wheat grown in Manitoba and North-West Territories in 1904, 59; Acidity of Flour, 60; Swamp Soils, 60; Abitibi Soils, 62; Insecticides and Fungicides: Lime-Sulphur Washes, 63; Fungeroid, 64; Perservatives in Butter, 64.

PART VI.—REPORT OF THE LECTURER IN CHEMISTRY 66

Teaching, 66; Condition of our Export Trade with Great Britain, 67.

PART VII.—REPORT OF THE PROFESSOR OF VETERINARY SCIENCE 70

Class Room, 70; Short Course in Stock Judging; Diseases of Stock, 71.

PART VIII.—REPORT OF THE PROFESSOR OF DAIRY HUSBANDRY 73

Improvements, 73; The Dairy School, 74; Experiments in Cheesemaking, 74; Rennet *vs.* Pepsin, 75; Moisture in Curd and Cheese, 76; Extra Rennet for Cheese Ripened in Cold Storage, 77; Placing Cheese on Shelves *vs.* Boxing, directly from the Press, 78; Effect of five different temperatures on Cheese ripening, 79; Ripening Cheese in Ice and Mechanical Cold Storage, 80; Experiments in Butter-making, 81; Pasteurizing Milk *vs.* Pasteurizing Cream, 82; Sweet Cream with Culture *vs.* Ripened Cream, 82; Churning Sweet Cream *vs.* Sweet Cream with Culture added, 83; Dry *vs.* Moist Parchment for Butter, 84: Cold Storage for Butter, 84; Blatchford's Sugar and Flaxseed for Cows and Calves, 85; Improved Molasses Cattle Food for Milch Cows, 85; Dairy Herd, 86; Comments on Herd Records, 87.

PART IX.—REPORT OF THE PROFESSOR OF ANIMAL HUSBANDRY AND FARM SUPERINTENDENT. 89

Visit to Great Britain, 89; Investigations Regarding Canadian Bacon on the British Market and the Production of Bacon in Denmark, 89; Farm Superintendence, 92; Notes on Feeding Stock, 94; Live Stock Experiments, 96; Outside Work, 96.

PART X.—REPORT OF LECTURER IN ANIMAL HUSBANDRY 97

Experiments with Swine: Blood Meal and Tankage as compared with Skim milk for Hogs, 97; Pigs on Pasture, 99; Soy Beans *vs.* Rape as Green Feed for Pigs, 100; Experiments in Steer feeding, 101.

PART XI.—REPORT OF THE PROFESSOR OF HORTICULTURE 102

Teaching, 102; Meetings Attended, 104; Reports and Articles Published, 104; Co-operative Testing of Small Fruits, 105; Trial Shipment of Fruit to Winnipeg, 105; Orchard Cover Crops, 106; Orchard Fruits, 109; The Bush Fruits, 110; Tomatoes, 112; The Vegetable Garden, 112; Ornamental Shrubs, 114.

PART XII.—REPORT OF THE PROFESSOR OF BACTERIOLOGY 117

Lectures, 117; Laboratory Work, 118; Meetings Attended, 118; Publications, 118; Routine Laboratory Work and Analyses, 118; Assistance, 119; Research Work, 119; Experimental Work, 123; Papers, etc., published, 126.

PART XIII.—REPORT OF THE PROFESSOR OF FIELD HUSBANDRY AND EXPERIMENTALIST 129

Outline of Work in Field Husbandry for 1904, 130; Experimental Work at the Agricultural College, 131; Results of Experiments, 133.

PART XIV.—REPORT OF THE MANAGER OF THE POULTRY DEPARTMENT 135

Hatching Eggs in January, 136; Later Hatching, 136; New Houses, 137; An Experiment to Force Fowls to Moult, 138; Cold Houses, 138; General treatment of Breeding Stock, 139; New Breeds of Fowls added during the year, 139; Geese, 139; Experiments in Fattening Chickens, 140; Testing Individuality, 141.

PART XV.—REPORT OF THE LECTURER ON APICULTURE 142

PART XVI.—REPORT OF THE LIBRARIAN 143

PART XVII.—REPORT OF THE PHYSICIAN 145

THE MACDONALD INSTITUTE.

ART I.—REPORT OF THE DEPARTMENT OF HOME ECONOMICS 147

Equipment, 147; Courses of Study, 147; Summary of Attendance, 150.

PART II.—REPORT OF THE DIRECTOR OF MANUAL TRAINING 152

The Agricultural Students, 152; Optional Course in Wood Carving, 154; The Consolidated School, 154; Nature Study Correlated Course, 154; Normal Course, 155.

PART III.—REPORT OF THE ACTING DIRECTOR OF NATURE STUDY 158

The Death of Dr. Muldrew, 158; The Courses in Nature Study, 160; Teachers' Normal Course of One Year, 161; Courses of Study and Practice, 161; Outlines of Nature Studies, 162; List of Nature Study Students, 164; Equipment for Nature Study, 165; The Relation of the Manual Training Department to Nature Study, 165: The Relation of the Macdonald Institute to the Rural Schools, 166; What is Nature Study?, 168; The Advantages of Nature Study, 170; The Agricultural Phase of Nature Study, 170; The Training of Teachers of Nature Study, 172.

I have the honor to be,

Your obedient servant,

G. C. CREELMAN, *President.*

ONTARIO AGRICULTURAL COLLEGE.

PART I.

REPORT OF THE PRESIDENT.

On the 1st of February, 1904, Dr. James Mills, President of the Ontario Agricultural College, accepted a position on the Railway Commission of the Dominion of Canada. I was then appointed President of this Institution, and assumed duties at once. Having graduated from the College in the first University Class in Agriculture in 1888, and having visited it every year with one exception since that time, I was more or less familiar with the work that was being carried on. During the year I have endeavored to familiarize myself with the duties of the position and its responsibilities.

The Staff.

I have received at the hands of the Professors of this Institution nothing but the utmost kindness. They have assisted me in every way since my coming among them, and I desire to bear witness at this time, not only to the hearty support which they are giving the President, but also to the zeal and enthusiasm which they are showing in their work.

Changes in the Staff.

Ever since the College was organized, the Professor of Agriculture has had complete charge of the farm, as well as the instruction work in live stock and field husbandry. The science of agriculture has made great advances in the last few years, and as a result, specialists have had to be called in to take charge of certain branches of the work. It has been thought best, therefore, to divide the former department of Agriculture, giving to Prof. C. A. Zavitz, our Experimentalist, a new branch of the work, to be known as the department of Field Husbandry. The subject of tillage, so far as it can be taught in the class-room and laboratory, has been transferred from the department of Agriculture to the department of Physics, under the direction of Prof. J. B. Reynolds, while Prof. G. E. Day retains all of the live stock work and the superintendence of the farm, and his branch of the work shall hereafter be designated as the department of Animal Husbandry.

As a result of this re-arrangement, Mr. W. H. Day, Demonstrator in Physics, has been promoted to a lectureship in that department; and in the department of Biology, Mr. T. D. Jarvis, was appointed Lecturer, in place of Mr. J. W. Hotson, who resigned in June to take the principalship of the new Consolidated Rural School.

Mr. M. Cumming, Lecturer in Animal Husbandry, has been appointed Principal of the College of Agriculture at Truro, Nova Scotia. Mr. Cumming leaves us on the 1st of February next, and I take occasion at this time to bear testimony to the efficient work of Mr. Cumming as Assistant and Lecturer at this College in connection with our live stock work.

The Late Dr. Muldrew.

On the afternoon of October the 7th, the entire College community was shocked by the news of the sudden death of Dr. W. H. Muldrew, Dean of Macdonald Institute. Dr. Muldrew was thirty-seven years of age, and had just commenced upon his life work,—the training of teachers and others in the science of Nature-Study. I have asked Professor Lochhead who was so closely associated with Dr. Muldrew in his work, to outline in detail the scope of the work which Dr. Muldrew had planned, and to tell something of his hopes and aspirations. The information will be found in the report of the department of Nature-Study.

Attendance.

As will be seen in the summary on another page, the attendance at the College during the year 1904 was the best in its history, 833 students having attended lectures during the year. The great majority were registered from Ontario, but every other Province in the Dominion was represented as well. England contributed sixteen; the Argentine Republic, sixteen; while Australia, Austria, Grenada, India, Jamaica, Scotland, Spain, United States, Uruguay, Newfoundland, and Switzerland, each sent one or more. The average age of students in attendance was twenty years.

Changes in the College Report.

For the first time, the College Report will contain an account of the work done in connection with Macdonald Institute. The three departments of Household Science, Manual Training, and Nature Study are now in full operation, and the attendance is much larger during this year than we anticipated. The total number of students in all classes at the Macdonald Institute during the year was 256. The reports of the heads of the different departments will be found at the back part of this report.

Macdonald Hall.

During the year the ladies' residence, known as Macdonald Hall, has been completed. With due regard to economy, the building has been furnished throughout in such a manner as to be pronounced convenient and comfortable by all the residents. The building accommodates 107 girls, and on the day of the Macdonald Opening, September the 20th, 1904, every room was taken.

Mrs. Fuller, Lady-Superintendent, by rare skill and tact, combined with wonderful energy and patience, has rendered most efficient service in opening the Hall and administering discipline during the first term.

Miss Kennedy, as Housekeeper, has also been faithful in her duties at all times.

The Government has undertaken to support Macdonald Institute and Macdonald Hall, and we are asking at this time for a grant sufficient to meet all necessary expenses.

Consolidated Rural School.

The piece of land lying between Macdonald Institute and the Brock Road was purchased some time ago by Professor Robertson for the purpose of erecting a consolidated school and for the laying out of play grounds and school gardens. During the year a splendid three-story building was constructed, and six teachers were engaged for the instruction of the children of the several adjacent school sections which had decided to unite and send

the children to a central school. As the land comprising the school grounds joins our College campus, we have, at the request of the trustees, assumed the responsibility of caring for the same; so that the school may be said to be situated on our College campus.

Mr. J. W. Hotson, formerly Lecturer in Biology at this College, is Principal of the new Consolidated School, and seems to be giving, in every particular, entire satisfaction.

College Work and Progress.

The work in the various departments of the College has gone on pretty much as usual. During the past year the class-room and laboratory work has been heavier than formerly, on account of the increased attendance of students.

The bulletins prepared by members of the College Staff and published by the Department of Agriculture during the past year are as follows:—

No. 134—"Hints in Making Nature Collections in Public and High Schools," by W. H. Muldrew.

No. 135—"The Cream-Gathering Creamery," by H. H. Dean and J. A. McFeeters.

No. 136—"Some Bacterial Diseases of Plants Prevalent in Ontario," by F. C. Harrison and B. Barlow.

No. 137—"A Bacterial Disease of Cauliflower and Allied Plants," by F. C. Harrison.

Through a liberal grant by the Government, we have been enabled to make several much needed improvements in the boys' dormitory. In this building, we have 181 students, two in each room, each accommodated with a single iron bed.

Through cramped accommodation in the kitchen, pantry, and store-room, the Matron found it hard to properly cater to the large number of students in attendance. During the year we have reconstructed the kitchen and pantries, have added a bake-room, and employed a competent baker, who makes all the bread used both at the College and Macdonald Hall, and in addition carves all the meat each day supplied to the College boys' dining-room. The carving of meats in the kitchen, rather than by the boys themselves in the dining-room, has effected a saving of many dollars each month, more than enough to pay the entire wages of the cooks and the carver and baker.

The lavatories have also been renovated, a wash-room has been added, and new bathrooms, with all modern fixtures, have been supplied.

The Matron.

On October the 1st, Mrs. Craig, who has been Matron at this College for fifteen years, resigned to make a home for her son in the city of Ottawa. I wish now to bear testimony to the long and faithful services of Mrs. Craig as Matron of this Institution. In case of sickness among the College boys, she was most attentive and sympathetic, and many a boy, when feeling badly and far from home, has had cause to bless the kindly, motherly attentions of Mrs. Craig.

Miss Hardy, of Orillia, has been appointed Matron at this Institution.

Short Courses.

So many of our farmers, who are in complete sympathy with the work we are doing here, find it impossible to leave home for many consecutive weeks. It was with the view of accommodating such persons that short courses in dairying, live stock judging, grain judging, and poultry raising,

were started at this College some three years ago. That these courses are being appreciated is evidenced by the fact of the continued large attendance. Last year there were 92 students in the Dairy Course, 132 in Stock and Seed Judging, and 23 in the Special Course in Poultry. Specialists in their several departments were brought to the College from other Provinces and some of the States of the Union to assist our own professors in the instruction work in the Short Courses.

Farmers' Institute Excursions to College.

It is really wonderful the way in which the farmers continue to visit this Institution, each year in the month of June. During 1904 the attendance was quite as large as usual, and it is estimated that between 35,000 and 40,000 persons visited the College during that month. They arrive usually about eleven o'clock, are conducted at once to the gymnasium, where lunch is provided, during the progress of which the President takes occasion to point out what is being done in the different departments of the College that is of interest to the practical farmer. After lunch, visitors are conducted over the farm, through the experimental plots, through the dairy, and through the poultry buildings. The ladies particularly are given an opportunity of seeing the workings of Macdonald Institute, and next year we will have a new feature, in the Rural Consolidated School, to show our farmer friends.

Needs of the College.

Under this heading, in the last report of the College, Dr. Mills made the following statement:—

"The most urgent needs of the College at the present time are increased dormitory accommodation; an Insectary for practical work in Entomology; a large building furnished with shafting, electric power, etc., for operating, comparing, and studying implements of different kinds during the winter months, when students have but little opportunity for practical work in the ordinary outside departments; and, last but not least, a new Bacteriological Laboratory, with a good isolation stable, for instruction and research in the boundless field which opens up before the investigator in this very important branch of scientific work,—closely connected, as it is, with soil fertility, dairying, stock raising, and every form of disease which afflicts man or beast. What a blessing it would be if the bacteriologists should succeed in finding, say, for hog cholera or for typhoid fever, such an anti-toxin as they not long ago found for diphtheria. And, in conclusion, it may not be amiss to call attention to the fact that the State of Michigan, U.S.A., has recently provided for its Agricultural College, Lansing, a Bacteriological Laboratory at a cost of $55,000, raised by direct taxation on the property of the State,—$30,000 for the building and $25,000 for equipment."

None of these needs asked for were provided; hence I ask for them again and in addition pray that money may be voted for the following absolutely necessary additions:—

(2) An addition to the Chemical Laboratory, rendered absolutely necessary by the increased attendance in our College classes, especially from Macdonald Institute.

(2) A new laundry building, with machinery and equipment to accommodate the needs of the students in Macdonald Hall and the College residence.

G. C. CREELMAN,
President.

STUDENTS OF THE YEAR.

ATTENDANCE.

The total number of students registered for work at the College in 1904 was 833, as follows:—

General Course	309	
Specials in General Course Work	21	
Dairy Courses	92	
Short Course in Stock and Seed Judging	132	
Short Course in Poultry Raising	23	
		577
At Macdonald Institute		
Domestic Science	148	
Nature Study	77	
Manual Training	31	
		256
Total in all Courses		833

ANALYSIS OF COLLEGE ROLL (GENERAL COURSE), 1904.

1. *From Ontario.*

Algoma	1	Kent	1	Prescott	2
Brant	12	Lambton	3	Prince Edward	3
Bruce	6	Lanark	5	Russell	1
Carleton	6	Leeds	3	Simcoe	13
Dufferin	6	Lincoln	6	Stormont	2
Dundas	8	Middlesex	8	Victoria	1
Durham	4	Muskoka	4	Waterloo	2
Elgin	4	Norfolk	3	Welland	3
Essex	4	Northumberland	3	Wellington	17
Frontenac	1	Ontario	6	Wentworth	17
Glengarry	7	Oxford	5	York	13
Grey	7	Parry Sound	2	Toronto	19
Halton	4	Peel	1		
Hastings	3	Perth	4		
Huron	6	Peterborough	1	Total	227

2. *From Other Provinces of the Dominion.*

Assinaboia	1	New Brunswick	4	Quebec	17
British Columbia	3	Nova Scotia	8		
Manitoba	2	Prince Edward Island	2		37

3. *From Other Countries.*

Argentina	16	India	1	Uruguay	1
Australia	1	Jamaica	4	Newfoundland	1
Austria	1	Scotland	2	Switzerland	1
England	16	Spain	1		
Grenada	1	United States	20		66

Ages and Religious Denominations.

The limits of age of students in the general course, 1904, ranged from 16 to 41 years. The average age was 20.

The religious denominations were represented as follows:—

90 Methodists, 88 Presbyterians, 70 Episcopalians, 29 Baptists, 27 Roman Catholics, 10 Congregationalists, 5 Disciples, 3 Friends, 2 New Jerusalem, 1 Christadelphian, 1 Lutheran, 1 Mennonite, 1 Plymouth Brethren, 2 with no church.

Counties represented in 1904.

It will be noted in the analysis of the College Roll that 41 Ontario counties and districts were represented in the General Course in 1904. There were 17 each from Wellington and Wentworth; 13 each from York and Simcoe; 12 from Brant; 8 each from Dundas and Middlesex; 7 each from Glengarry and Grey; 6 each from Bruce, Carleton, Dufferin, Huron, Lincoln, and Ontario; 5 each from Lanark and Oxford; and smaller numbers from other counties.

Bachelors of the Science of Agriculture.

Arkell, H. S.	Teeswater, Bruce, Ont.
Avila, C.	Cordoba, Argentine.
Barber, T. C.	Yorkton, Assa.
Bray, C. I.	Kleinburg, York, Ont.
Buchanan, D.	Florence, Lambton, Ont.
Bustamante, R. S.	Jujuy, Argentine.
Carpenter, G. H.	Fruitland, Wentworth, Ont.
Cutting, A. B.	Guelph, Wellington, Ont.
Dewar, W. R.	Fruitland, Wentworth, Ont.
Fausher, B. W.	Florence, Lambton, Ont.
Fulmer, H. L.	Ruthven, Essex, Ont.
Galbraith, S. M.	Ellesmere, York, Ont.
Hamilton, W.	Ravenshoe, York, Ont.
Johnston, J. P.	Fingal, Elgin, Ont.
MacRae, C. M.	Cumberland, Russell, Ont.
Panelo, J.	Buenos Ayres, Argentine.
Peltzer, J.	Buenos Ayres, Argentine.
Pickett, B. S.	Vittoria, Norfolk, Ont.
Readey, J. C.	Rosetta, Lanark, Ont.
*Rivett, T. B.	Spanish Town, Jamaica.
Thom, C. C.	Elma, Dundas, Ont.

*To pass Supplemental Examination in English.

Recipients of Associate Diplomas.

Bailey, C. F.	Coldbrook, N. S.
Baker, M. R.	Swarthmore, Penn., U. S. A.
Ballantyne, R.	Sebringville, Perth, Ont.
Bean, W.	Haysville, Waterloo, Ont.
Birley, R. B.	Paris, Brant, Ont.
Bracken, J.	Seeley's Bay, Grenville, Ont.
Breckon, W. D.	Waterdown, Wentworth, Ont.
Colwell, H. H.	Oakville, Halton, Ont.
Dickson, J. R.	Seaforth, Huron, Ont.
Elderkin, J. B.	Amherst, N. S.
Evans, W. G.	Guelph, Wellington, Ont.
Gamble, T.	Mosgrove, Carleton, Ont.
Halliday, C.	Pakenham, Lanark, Ont.
Hart, F. C.	Wallace Bay, N. S.
Hawtin, A.	Newmarket, York, Ont.
Jones, D. H.	Bedford Park, York, Ont.
Kitchen, A. F.	St. George, Brant, Ont.
Klinck, C. R.	Victoria Square, York, Ont.
Leavens, H.	Chisholm, Prince Edward, Ont.
Lund, T. H.	Compton, Quebec.
McBeth, D.	Ormsby, Hastings, Ont.
McKenny, A.	Corinth, Elgin, Ont.
McKenzie, J.	Queen Hill, Bruce, Ont.
McMillan, H. R.	Aurora, York, Ont.
Macdonald, C. M.	Halifax, N. S.
MacVannel, A. P.	St. Marys, Perth, Ont.
Manchester, P.	Apohaqui, N. B.
Marino, A. E.	Buenos Ayres, Argentine.
Marshall, C. A.	Westbrook, Frontenac, Ont.
Metcalf, H. M.	Grimsby, Lincoln, Ont.

RECIPIENTS OF ASSOCIATE DIPLOMAS.—*Continued.*

Middleton, M. S. ..... Vernon, B. C.
Monroe, J. F. ..... South End, Welland, Ont.
Murray Wilson, J. G. ..... Monte Video, Uruguay.
Nixon, C. C. ..... St. George, Brant, Ont.
Northcott, S. A. ..... Solina, Durham, Ont.
Ramsay, R. L. ..... Toronto, Ont.
Robertson, A. ..... Brantford, Brant, Ont.
Scott, H. W. ..... Lancaster, Glengarry, Ont.
Sloan, R. R. ..... Blyth, Huron, Ont.
Smith, H. B. ..... Wanstead, Lambton, Ont.
Stayner, H. S. ..... Toronto, Ont.
Taylor, H. E. ..... Colchester, Essex, Ont.
Tucker, H. S. ..... Chapman, Hastings, Ont.
Weir, D. ..... Montreal, Que.
White, G. G. ..... Perth, Lanark, Ont.
Zubiaur, A. ..... Buenos Aires, Argentine.

FIRST CLASS MEN.

The work of the College is divided into departments, and all candidates who obtain an aggregate of seventy-five per cent. of the marks allotted to the subjects in any department are ranked as first class men in that department. The following list contains the names of those who gained a first-class rank in the different departments at the examinations in 1903, arranged alphabetically:—

First Year.

Baker, J. Solina, Durham, Ont., in one department; English and Mathematics.

Bunting, *T. G.*, St. Catharines, Lincoln, Ont., in two departments; English and Mathematics, and Physical Science.

Higginson, *T. D.*, Hawkesbury, Prescott, Ont., in one department; English and Mathematics.

Kennedy, *J. W.*, Apple Hill, Glengarry, Ont., in two departments; English and Mathematics, and Physical Science.

Meek, *N. W.*, Port Stanley, Elgin, Ont., in one department; English and Mathematics.

Montgomery, *C. G.*, New Richmond, Quebec, in one department; English and Mathematics.

Sanders, *G. E.*, Round Hill, Annapolis, N.S., in one department; Physical Science.

Twigg, *C. B.*, O. A. C., Guelph, Ont., in two departments; English and Mathematics, and Physical Science.

Winslow, *R. M.*, London, Middlesex, Ont., in four departments; English and Mathematics, Physical Science, Biological Science, and Agriculture.

Second Year.

Ballantyne, *R.*, Sebringville, Perth, Ont., in two departments; English and and Economics, and Biological Science.

Bracken, *J.*, Seeley's Bay, Grenville, Ont., in three departments; English and Economics, Physical Science, and Biological Science.

Dickson, *J. R.*, Seaforth, Huron, Ont., in one department; English and Economics.

Hart, *F. C.*, Wallace Bay, N.S., in one department; English and Economics.

Kennedy, A. B., Winchester, Dundas, Ont., in one department; English and Economics.
Kitchen, A. F., St. George, Brant, Ont., in one department; English and Economics.
Lund, T. H., Chorley, England, in two departments; English and Economics, and Physical Science.
McMillan, H. R., Aurora, York, Ont., in one department; English and Economics.
Smith, H. B., Wanstead, Lambton, Ont., in one department; English and Economics.
Stayner, H. S., Toronto, Ont., in one department; English and Economics.
Tennant, L., Falkland, Brant, Ont., in three departments; English and Economics, Physical Science, and Biological Science.
Tucker, H. S., Chapman, Hastings, Ont., in one department; English and Economics.

Scholarships.

Scholarships of $20 each in money were awarded for groups of subjects in first year work as follows:—Highest standing with a minimum of forty per cent. of the marks for each subject, and an aggregate of seventy-five per cent. of the total number of marks allotted to the subjects in the group:—

1. English, Mathematics, Book-Keeping, and Drawing—J. W. Kennedy, Apple Hill, Glengarry, Ont.
2. Physics, Chemistry, and Geology—W. G. Bunting, St. Catharines, Lincoln, Ont.
3. Agriculture, Dairying, Poultry, Apiculture, and Veterinary Science —R. M. Winslow, London, Middlesex, Ont.

Prizes.

Prizes amounting to $10 each, in books, were given as follows:—

1. Essay on "Macaulay as an Essayist and Writer of English Prose" D. H. Jones, Bedford Park, York, Ont.
2. First in General Proficiency, first and second year work, theory and practice—J. Bracken, Seeley's Bay, Grenville, Ont.
3. First in General Proficiency with first class honors in major subjects, fourth year—B. S. Pickett, Vittoria, Norfolk, Ont.

Governor General's Silver Medal.

Highest in general proficiency, second year, 1903-04—J. Bracken, Seeley's Bay, Grenville, Ont.

Professional Dairy School Certificates.

The following list includes the names of those who have obtained Professional Certificates from the Dairy School since its inception. The first certificates were issued to the class of 1893.

1899.	Atwood, C. S.	Arkona, Ont. — Cheesemaking.
1895.	Baird, A. K.	Winnipeg, Man. — Buttermaking.
1902.	Ball, C.	Guysboro', Ont. — Cheesemaking.
1899.	Barberree, A.	Corwhin, Ont. — Cheesemaking.
1898.	Bell, H. J.	Oxley, Ont. — Buttermaking.
1896.	Biffin, J.	Tavistock, Ont. — Cheesemaking.
1895.	Biggin, E. O.	Vernon, O., U. S. A. — Cheesemaking.
1895.	Boyes, F.	Nilestown, Ont. — Cheesemaking.
1897.	Boyes, F.	Evelyn, Ont. — Cheesemaking.
1893.	Boyes, G. A.	Evelyn, Ont. — Cheesemaking.

PROFESSIONAL DAIRY SCHOOL CERTIFICATES.—*Continued.*

1894.	Brayley, G. B.	Marston, Ont.	Cheesemaking.
1894.	Brodie, G. B.	Gladstone, Ont.	Cheesemaking.
1894.	Calder, A. G.	Winthrop, Ont.	Cheesemaking.
1898.	Callan, P.	Innerkip, Ont.	Cheesemaking.
1895.	Code, B.	Burritt's Rapids, Ont.	Cheesemaking.
1895.	Coomber, H.	Straffordville, Ont.	Cheesemaking.
1896.	Daigle, C.	St. Louis, N. B.	Buttermaking.
1897.	Dangerfield, J. A.	Oxford Mills, Ont.	Buttermaking.
1904.	Dobbie, G. S.	Guelph, Ont.	Buttermaking.
1902.	Echegaray, S.	Santiago, Argentine	Buttermaking.
1894.	Elliott, W. J.	Thomasburg, Ont.	Buttermaking.
1897.	Flack, S.	Red Deer, N. W. T.	Buttermaking.
1898.	Fotheringham, J. W.	Courtice, Ont.	Cheesemaking.
1895.	Henricks, K.	Headford, Ont.	Buttermaking.
1895.	Hill, Geo. W.	Summerhill, Ont.	Cheesemaking.
1895.	Hill, J. A.	Conway, Ont.	Cheesemaking.
1903.	Hitchings, C. E.	Chaffee, N. Y., U. S. A.	Cheesemaking.
1903.	Holm, E.	Hespeler, Ont.	Buttermaking.
1898.	Hope, W.	Palermo, Ont.	Buttermaking.
1900.	Hutchinson, J. R.	St. George, Ont.	Buttermaking and Cheesemaking.
1901.	Gibson, J. W.	Walkerton, Ont.	Cheesemaking.
1897.	Gracey, A. E.	Currie's Crossing, Ont.	Cheesemaking.
1899.	Immell, G. J.	Mildmay, Ont.	Cheesemaking.
1896.	Kinney, G.	Winthrop, Ont.	Cheesemaking.
1899.	Knight, A.	Sardis, B. C.	Buttermaking.
1900.	Lockyer, E.	New Durham, Ont.	Cheesemaking.
1898.	Marshall, E. G.	Guysboro', Ont.	Cheesemaking.
1897.	Menzies, G.	Molesworth, Ont.	Cheesemaking.
1895.	Millar, J. F.	Brantford, Ont.	Cheesemaking.
1894.	Milne, R. R.	Paisley, Ont.	Cheesemaking.
1895.	Mitchell, H.	Keswick Ridge, N. B.	Cheesemaking.
1898.	McCready, J.	Harriston, Ont.	Cheesemaking.
1899.	McDiarmid, A.	Aberfoyle, Ont.	Buttermaking.
1896.	McMillan, D.	Harrington, Ont.	Cheesemaking.
1903.	McDonald, A. C.	Navan, Ont.	Cheesemaking.
1898.	McDougall, C. W.	Guelph, Ont.	Cheesemaking.
1902.	McDougall, W.	Truro, N. S.	Cheesemaking and Buttermaking.
1899.	McKay, W. A.	Underwood, Ont.	Cheesemaking.
1899.	Nesbitt, J. R.	Walkerton, Ont.	Buttermaking.
1899.	Newman, J. W.	Roebuck, Ont.	Cheesemaking.
1902.	Parry, H. W.	Compton, Que.	Buttermaking.
1894.	Perry, A. D.	Wilton, Ont.	Cheesemaking.
1897.	Reynolds, H. E.	Solina, Ont.	Buttermaking.
1895.	Robertson, J.	Athens, Ont.	Cheesemaking.
1904.	Rolph, C. H.	London, Ont.	Cheesemaking.
1899.	Sandwith, H.	Sandhurst, Ont.	Cheesemaking.
1899.	Sheffield, R. D.	Gilead, Ont.	Cheesemaking.
1902.	Singleton, J. F.	Newboro', Ont.	Cheesemaking.
1895.	Singleton, W. M.	Newboro', Ont.	Cheesemaking.
1895.	Smith, F. W.	Guelph, Ont.	Buttermaking.
1895.	Smith, H.	Clarence, Ont.	Buttermaking.
1895.	Stilman, R. C.	Campbellford, Ont.	Cheesemaking.
1896.	Stocks, W. S.	Dundalk, Ont.	Cheesemaking.
1895.	Stonehouse, J.	Port Perry, Ont.	Buttermaking.
1894.	Stratton, R. W.	Straffordville, Ont.	Cheesemaking.
1901.	Thompson, W. G.	River View, Ont.	Cheesemaking.
1902.	Thompson, J. H.	Laurel, Ont.	Cheesemaking.
1896.	Tilley, J. F.	Woodstock, N. B.	Cheesemaking.
1895.	Waddell, W.	Kinloss, Ont.	Cheesemaking.
1900.	Wagg, A. J.	Mindemoya, Ont.	Buttermaking.
1896.	Wallbridge, L.	Belleville, Ont.	Buttermaking.
1898.	Wheaton, A. M.	Upper Sackville, N. B.	Cheesemaking and Buttermaking.
1898.	Wiancko, T. A.	Sparrow Lake, Ont.	Buttermaking.
1900.	Witt, W. C.	Barrie, Ont.	Buttermaking.

FINANCIAL STATEMENT, 1904.

COLLEGE EXPENDITURE.

College Maintenance.			
Salaries and Wages:		34,781 67	
Meat, fish, fowl		5,732 13	
Food:			
Bread, biscuits		1,173 42	
Groceries, butter, fruit		6,660 84	
Household Expenses:			
Laundry, soap, cleaning		316 52	
Women servants' wages		2,261 91	
Business Department:			
Advertising, printing, postage, and stationery		2,412 37	
Miscellaneous:			
Maintenance of Chemical Laboratory		735 58	
do Physical do		582 75	
do Biological do		580 24	
do Bacteriological do		479 98	
Library, reading room, books, papers, etc		2,246 12	
Scholarships		83 50	
Unenumerated		2,921 61	
Short Courses in Stock Judging		608 23	
Telephone service, rents, and messages		181 00	
School Assessment, S. S. No. 7		92 40	
Temporary assistance		770 00	
Travelling Expenses		846 65	
Student labor (per statement below)		4,001 36	
			67,468 28
Maintenance and Repairs of Government Buildings:			
Furniture and furnishings		1,782 08	
Repairs and alterations		1,493 63	
Fuel		9,966 87	
Engine room supplies		603 76	
Sewage disposal		504 12	
			14,350 46
Macdonald Institute: Salaries and Maintenance			16,625 20
Forestry			2,907 90
			$101,351 84
College Revenue			
Fees		3,844 07	
Board accounts		14,977 68	
Supplemental exams.		55 00	
Rent of Post Office boxes (Sept. 1904, Sept. 1905.)		38 00	
Sundries		34 44	
Breakages		39 60	
Fines. College		126 35	
do Library		7 30	

FINANCIAL STATEMENT.—*Continued.*

COLLEGE REVENUE.—*Continued.*

Sale of Whittaker House	400 00		
Bacteriological Laboratory Sale of solution	2 00		
Chemical Laboratory. Sale of acid, analysis of city water	60 25		
		19,584 69	
MACDONALD INSTITUTE. REVENUE:			
Board		4,098 84	
Fees		2,716 65	
			$26,400 18
Net expenditure			74,951 66

STUDENT LABOR, 1904. TO DIFFERENT DEPARTMENTS.

Totals per month		*Analysis per year.*	
January	243 62	College	350 46
February	334 38	Macdonald Institute	59 63
March	268 09	Grading Macdonald Grounds	63 51
April	169 93	Forestry	21 45
May and June	772 70	Engine Room	32 60
July	398 87	Chemical Laboratory	147 67
August	139 81	Bacterial do	6 23
September	321 25	Biological do	26 71
October	587 38	Physical do	66 32
November and December	765 33	Horticultural Dept.	696 97
		Mechanical do	312 59
		Farm	968 28
		Experimental do	696 19
		Poultry do	210 77
		Dairy do	345 98
	$4,001 36		$4,001 36

FARM EXPENDITURE.

Permanent Improvements		455 49	
Maintenance:			
Wages of foreman and men	3,966 75		
Live stock and cattle for feeding	8,455 40		
Feed	1,273 51		
Seed	209 08		
Binder twine	56 00		
Repairs, alterations, blacksmithing, etc	876 29		
Furnishings	78 04		
Tools and implements	285 70		
Advertising, printing, postage and stationery	99 45		
Fuel and light	2 38		
Experimental Feeder	407 86		
*Contingencies	389 10		
Thresher	765 75		
		16,865 31	
			$17,320 80

*Telephone service transferred to Miscellaneous in Audit Office Report, and $36.75 paid direct not included here.

Net expenditure allowing nothing for supplies to College, feed for Dairy Stock, keep for horses for Colleg and other Departments.

This statement includes only the cash transactions for the year.

Decrease in Revenue on account of Stock Sale in 1903.

FINANCIAL STATEMENT.—*Continued.*

REVENUE.

Sale of Stock:

Cattle 30 head	1,810 80	
Pigs 204 "	1,742 69	
Sheep 14 "	70 25	
" Dressed carcasses. Short courses	518 46	
Miscellaneous Sales:		
Potatoes	160 65	
Hay	10 00	
Grain	142 48	
Wool	34 56	
Tank	2 00	
Haytedder	5 00	
Milk	3 56	
Services of animals	151 50	
		4,651 95
Net expenditure		12,668 85

FIELD EXPERIMENT EXPENDITURE.

Permanent Improvements:			559 89
Experimentalist	Salary	1,900 00	
Foreman	do	700 00	
Teamsters	do	644 70	
Laborers	do	2,092 00	
Seed		470 11	
Manure		76 74	
Furnishings, repairs, blacksmithing, etc		301 12	
Printing, postage, stationery, etc.		120 39	
Stenographer		317 10	
Assistant Experimentalist		529 50	
Specialist in Plant Breeding		700 00	
Demonstrator in Field Husbandry		500 00	
Contingencies		128 70	
Implements		131 78	
Typewriter		100 00	
Horse		160 00	
			8,872 14
Total expenditure			$9,432 03

DAIRY DEPARTMENT EXPENDITURE.

Permanent Improvements:			579 39
Wages of Engineer (8 months)		247 50	
" Cheesemaker "		425 02	
" Buttermaker "		375 00	
" Cattleman "		432 00	
Temporary assistance		258 28	
Milk		9,145 46	
Cows		525 26	
Feed		439 09	
Furnishings and repairs		769 90	
Laboratory expenses		52 43	
Fuel and light		666 99	
*Contingencies		373 89	
			13,710 82
			$14,290 21

*Telephone service transferred to Miscellaneous in Audit Office Report.
Allowing nothing for cream or milk supplied to College.

FINANCIAL STATEMENT.—*Continued.*

REVENUE.			
Sale of Butter : 50,754 lbs. @ from 13c to 25c	9,750 34		
Cheese : 9,915¾ lbs. @ from 8¼c to 11c	997 92		
Milk : 3,179 qts. @ 4c	127 15		
Skimmilk	130 80		
Cream : 63 gal @ 60c, $37.80; 176½ qts. @ 20c, $35.30	73 10		
Cattle : 10 dry cows $305.00, 2 heifers $45.00, 2 bull calves $50,00, 16 grade calves $75.50	475 50		
Hides :	11 50		
Sundries :	2 30		
		11,568 61	
Net expenditure		2,721 60	
DAIRY SCHOOL EXPENDITURE.			
Wages of Instructors	1,714 80		
" Engineer	148 50		
Furnishings, repairs and appliances	496 85		
Fuel and light	644 56		
Advertising, printing, postage and stationery	197 28		
Contingencies	162 82		
Milk, for use in school	6,507 97		
Permanent improvements	300 00		
Travelling expenses	65 40		
Painting and cleaning	195 27		
Books, periodicals, etc	2 85		
		10,436 30	
REVENUE.			
Fees :	86 00		
Sale of Butter : 17,738¾ lbs. @ 16c to 24c	3,939 07		
Cheese : 5,736 lbs. @ from 9c to 11c	574 39		
Skimmilk :	13 36		
Cream : 113.3 gals. @ 85c, $96.30; 6½ qts. @ 20c, $1.25	97 55		
Milk : 1,260 qts. @ 4c	50 40		
Sundries :	10 60		
		4,771 37	
Net expenditure		5,664 93	
POULTRY DEPARTMENT EXPENDITURE.			
Permanent Improvements		100 00	
Temporary assistant	331 91		
Purchase of stock	133 99		
Feed, etc	262 73		
Furnishings and repairs	196 79		
Fuel and light	144 47		
Experiments in fattening	970 20		
Incubator experiments	49 43		
*Contingencies	228 52		
		2,318 04	
			$2,418 04
REVENUE.			
Sale of Eggs : for hatching, 73½ set 141.00; for domestic use, 537 doz 109.18	250 18		
Live Birds, 248 312.50			
Dressed birds 344.00			
	656 50		
			906 68
Net expenditure			1,511 36

*Telephone service transferred to miscellaneous in Audit Office Report.

FINAMCIAL STATEMENT.—*Concluded.*

HORTICULTURAL DEPARTMENT EXPENDITURE.

Permanent Improvements		36 55	
Foreman	750 00		
Florist	650 00		
Assistant in Greenhouse	450 00		
Teamsters	679 00		
Wages	1,505 24		
Manure	98 75		
Trees, seeds, plants and bulbs	231 48		
Furnishings, repairs, implements and tools	583 34		
Fuel and light	948 39		
*Contingencies	130 34		
Wax models of fruit	369 24		
Horses	360 00		
		6,755 78	
			6,792 33
REVENUE.			
Sale of vegetables	2 15		
" cut greens	50		
		2 65	
Net expenditure			6,789 68

MECHANICAL DEPARTMENT.

Foreman	750 00	
Tools	151 05	
		901 05

SUMMARY OF NET EXPENDITURE.

College, Macdonald Institute and Government Buildings	74,951 66	
		74,951 66
Farm :		
Farm proper	12,668 85	
Field experiments	9,432 03	
		22,100 88
Dairy :		
Experimental dairy	2,721 60	
Dairy school	5,664 93	
		8,386 53
Poultry	1,511 36	
		1,511 36
Horticultural	6,789 68	
		6,789 68
Mechanical	901 05	
		901 05
Total net expenditure		$114,641 16

Yours truly,

S. SPRINGER,

Bursar and Superintendent.

*Telephone service transferred to miscellaneous in Audit Office Report.
The produce from this department used by the College.

PART II.

THE DEAN OF RESIDENCE.

To the President of the Ontario Agricultural College:

SIR,—I have pleasure in submitting herewith a report of my first year's work as Dean of Residence and Instructor in English and Bookkeeping.

As Instructor in English, my work has comprised lectures in English Grammar, English Composition, and Rhetoric, and English Literature. In Grammar I have endeavored to give to the students a working knowledge of the laws governing the use of words, their forms, inflections and combinations. In Rhetoric the course has consisted of such a study of the fundamental rules of English prose construction as would enable the students to write good English prose and to study intelligently and appreciatively the style of English prose authors. Thus the form and structure of sentences has first been dealt with, then the combining of sentences into paragraphs, and later the union of paragraphs into a connected essay. In Composition the object has been to give practice in the application of the laws of rhetoric, and training in clear thinking and correct, forcible expression. For this purpose I have had the classes write essays on such topics as: "An Incident of My Summer Vacation," "My Reading During 1904," "Rural Mail Delivery," "The Grand Trunk Pacific Railway," "Agricultural Education," and "The Improvement of Farm Animals." These essays I have read and returned, with corrections and suggestions for improvement. In teaching English Literature, both prose and poetry, I have endeavored not merely to arouse the interest of the students in the text studied, but by frequent quotations and references to awake a lasting interest in English Literature as a great storehouse of knowledge and pleasure.

The course in Bookkeeping comprises business correspondence, commercial forms, and the keeping of farm and other accounts.

At the close of the winter term a course of six weeks' instruction was given for students who had not completed their matriculation. During this course I gave lectures in English Literature, Rhetoric, and Composition, and in English and Canadian History.

As Dean of Residence, it has been my duty to preside in the College dining hall, to inspect the residence building and furniture and have repairs made when necessary, to superintend evening study, to conduct roll-call and prayers, and generally to supervise the conduct of the students.

During the past winter term the regular routine of the residence was seriously interfered with by the quarantine and isolation regulations. With this exception, my work in charge of the residence has been most enjoyable. Realizing that the life in residence is one of the most important features of the college training, I have sought to develop among the students a wholesome college spirit, combined with a sense of individual responsibility. In this endeavor I have had your hearty support and co-operation, and it is gratifying to see the students exercising a manly self-control in their conduct, and learning to take pride in their college home.

The latter is in large measure due to the many improvements which have been made during the summer. These have added much to the attractiveness of the residence, both in appearance and in the better accommodation afforded. The wood-work has been repainted, the dining hall has been furnished with handsome new chairs, and is very much brighter and more pleasant; the kitchen has been enlarged and equipped with modern appliances. The addition of a baker to the kitchen staff has caused a marked improvement in the quality and variety of the fare provided. Also the addition of large and well appointed bath and wash rooms has aided much in promoting the convenience and cleanliness of the students. The advantages of these improvements are seen not only in the increased comfort of the students, but in a higher standard of conduct responsive to the greater refinment of their surroundings. However, though many changes have been made, one important addition has yet to be provided—lockers for the working clothes of the students.

In conclusion I wish to thank you for your sympathy and support, and for the many improvements which have rendered my duties more pleasant by creating among the students, a feeling of greater thoughtfulness and consideration.

Respectfully submitted,

F. H. REED.

PART III.

THE PROFESSOR OF PHYSICS AND LECTURER IN ENGLISH.

To the President of the Ontario Agricultural College:

SIR,—I have the honor to submit herewith my tenth Annual Report in the departments of Physics and English.

INSTRUCTION IN ENGLISH.

The work in English extends over the four years of the College course. It consists (1) a study of English authors, including Washington Irving, George Eliot, Macaulay, and Carlyle, prose writers; and Shakespeare, Milton, Wordsworth, and Tennyson, poets; (2) practical composition—the writing of essays and articles, continued through the four years; (3) practice in public speaking, with criticism by an officer of the College, in the second and third years.

English Authors. It is no longer necessary to apologize for the appearance on the curriculum of this branch of study. It is generally conceded that an acquaintance with the best writers in our language is part of the mental equipment of every well-informed man, be he farmer or physician. Within my experience the students here have always conceded this; nay, have urged it. Besides, the study of English authors, especially prose authors, is made the occasion for instruction in practical composition, the authors' choice of words, and their qualities of style generally, forming models for rhetorical analysis. The work in English authors is taken for the first and second years by the Dean of Residence, and for the third and fourth years by myself.

Practical Composition. It will doubtless be the fortune of very many of our students to contribute, occasionally or frequently, to the columns of agricultural journals. Next to success in his calling, nothing is more creditable to a practical farmer than to write calmly, intelligently, and *intelligibly* on matters pertaining to his business, or to the public welfare. Further, not a few of our students have aimed, and are aiming, at agricultural journalism as a profession. Our purpose in this branch of the work is, by giving students frequent practice in writing and by pointing out wherein they may improve these efforts, to make them masters of correct, strong, serviceable English. In this direction it is gratifying to note the improvement made from year to year. The work under this head is divided as is that in English authors.

Public Speaking. It is not exceeding the truth to say that the great majority of the students welcome the opportunity now afforded for acquiring some proficiency in platform speaking, and that the number who can acquit themselves creditably in this direction is increasing year by year. Of course,

there are some men who, by possession of marked aptitude for speech-making, would become proficient without the special training that the College affords. But, with considerable gratification, not to say surprise, I have observed the development of the unlikely man. While these classes aid all, they are of especial benefit to the man of average ability in speaking, for the diffident man who is unaware of his own powers. As frequently as time permits each man is given the opportunity to prepare and to speak on a subject, and a few minutes of each period are devoted to common sense criticisms of the speeches—criticisms touching upon the pupils' manner, voice, enunciation, diction, and choice or treatment of theme. The second year classes have been taken by Mr. Cumming, while last year and this year a little additional training has been given to the third year by myself.

It would be in the interest of the whole work in English if it could be placed under the charge of a professor appointed to that department. As it is now, while the English is nominally under my charge, I have the department of Physics also, which, to do it justice, would require the full time of the professor and the assistant; and the temptation to specialize in a branch of agricultural science, natural and proper at an agricultural college, is not favorable to another subject that happens to be joined with it under the same management. I therefore recommend that the appointment of a professor of English be early considered.

Instruction in Physics.

The instruction in Physics now covers the four years of the course for the B. S. A. degree. For the Associate degree the work of the first year includes Soil Physics and Mechanics. Owing to the readjustment of the work among the three departments, Animal Husbandry, Field Husbandry, and Physics, the instruction in Drainage and Tillage, in so far as the latter is related to the physical properties of the Soil—its texture, temperature and moisture—has been formally handed over to the Department of Physics. Accordingly it was thought best to place the elementary part of the work in Soil Physics and Tillage in the first year of the course, to take the place of part of the work in Field Agriculture that had formerly been given in the first year by the Department of Agriculture. The course in the second year comprises Surveying, Levelling and Drainage, Ventilation and Heating considered practically, Mechanics of Water Supply, Electricity, and other subjects that may be included under the term Agricultural Engineering. In the third year the Theory of Heat prepares the way for Meteorology, Cold Storage, and the Theory of Ventilation and Heating. The fourth year course consists of Climatology, or Climate in relation to Agriculture, and advanced work in Soil Physics.

A few words of explanation of some of the above subjects may serve to show their fitness to stand on the curriculum of an Agricultural College. The subject of Agricultural Engineering is a very wide one, of which we have as yet touched upon only the most important particulars. Under this subject, by means of instruction, demonstration, and practice, we aim to enable our students to measure their own farms and to map out their boundaries, physical features and subdivisions; to plan and to carry out systems of drainage that shall be suited to the particular circumstances of the sections to be drained, and to calculate beforehand the approximate cost; to devise and to carry out plans for a convenient water-supply, adapting the power to be used to the circumstances of the case, and contriving to bring water to the farm house and farm stables; to ventilate houses and stables; and to understand the

principles and the uses of machinery. The mastery of this subject, it may be observed, requires a knowledge of chain surveying, of methods of calculating areas, and of drawing plans and maps; it requires a knowledge of the properties of soil, their behavior toward water and air; a knowledge of hydraulics, of the laws that govern the flow of water; of mechanical devices, such as the windmill, the hydraulic ram, and of various types of pumps and motors; of the properties of air; and of mechanics. Since the object of this course is not to give scientific acquaintance merely, but practical mastery chiefly, the sciences that underlie these various topics have to be presented with care and discrimination lest the scientific aspect consume too much space. At the same time, I hold strongly to the opinion that a thorough mastery of *principles* underlying any practice is worth much more than a mere mass of facts, directions, and specifications.

Meteorology is the science of the Weather, and as such it is a perennially interesting subject. It leads one to observe, and enables one to understand, those wonderful natural phenomena, winds and storms, rain, hail, and snow, frost and heat, and the ever-varying forms of cloud and colors of sky. It is a branch of Nature Study, but it has its practical issues also. The Weather Bureau at Toronto issues daily forecasts of the weather for the next twenty-four hours. These forecasts are published immediately in various ways. Some years ago the forecasts were made known by colored flags carried on railway trains, but, while I believe the practice is still continued in some sections, the Bureau found that, owing to neglect of railway employees, the announcements thus made were unreliable. Another method of publication is by telegraph, central points being informed of the forecasts, from which points the news may be repeated by telegraph or telephone where required. Besides this, weather maps are issued daily and are distributed by mail as soon as the forecasts are made, and those in reach of the Bureau may receive the map on the same day as issued, and from it may make their own forecasts. To be forewarned is to be forearmed, and it is evident that if the farmer or the fruit-grower is aware of what the weather will probably be within the next twenty-four hours he may in many ways guard against damage and loss. The fruit-grower especially may, if he is aware of approaching frost, take preventive measures. Recently the editor of the *Canadian Horticulturist* suggested to me that I prepare a series of articles on Methods of Preventing Damage from Frost. I have in preparation an instrument that will give warning when the temperature has fallen sufficiently low to indicate probable danger from frost, and as soon as I have this tested, I expect to prepare the series of articles rquested, dealing with various methods used to ward off frost from vineyards and orchards.

Climatology deals with the causes of climatic differences, with the factors of climate that distinguish one district from another, and with the effect of climate on agriculture. Under this head are studied particularly the climatic factors of the various provinces of Canada, the climatic limits for different species of farm produce, grains, vegetables, and fruits, and the suitability of any given section, climate and soil considered together, for any given variety of fruit or other crop. Not only is valuable information gained in this study, but the importance of considering climatic factors is emphasized, so that in introducing a new crop into a district, or in selecting crops for the new districts of Ontario and the Northwest, certain foregone conclusions may prevent costly experiments with unsuitable varieties. Exact information upon the climatic peculiarities of the new districts now being opened up cannot be too widely disseminated. It is our object in giving instruction and collecting information upon this subject, to disseminate such exact knowledge.

Additional Lecture Courses.

Besides the work as outlined above for the regular College courses, I gave a series of lectures and demonstrations on Soil Physics and Climatology, to the class of teachers in the summer Nature Study course; a similar series to the Nature Study Class in the autumn term; a course of three or four lectures on Cold Storage to the Dairy Class last winter; a course on ventilation to the Poultry Class; and an address on Shipping Fruit in Cold Storage before the Experimental Union in December.

Correspondence, Articles, and Bulletins.

The correspondence of this department, while not heavy, is rapidly increasing. During the past year I have replied to many questions relating to subjects belonging to this department, such as ventilation, water power, conveying water from springs, creeks, and ponds to the house and stable, building cold storage houses, controlling temperatures in refrigerators, drainage, and tillage. Also, several samples of soil have been examined and reported upon.

During the year, I have contributed the following articles to the press: Lampman's Nature Poetry, Canadian Literature, Experimental Shipment of Fruit, *O. A. C. Review;* Experimental Shipment of Fruit, *Canadian Grocer;* Experimental Shipment of Fruit, The Western Fruit Market, *Canadian Horticulturist;* Fruit for the Market, Farmers' Institute Report; Ventilation and Heating, Water Supply for the Farm, *Farmers' Advocate.*

I have recently sent to the Department of Agriculture for publication a bulletin on "An Experimental Shipment of Fruit to Winnipeg," this bulletin being a report of a trial shipment in cold storage of various kinds of fruit from Southern Ontario. A summary of the results of this shipment may be found on another page in this report.

Outside Work.

Apart from the College work I have given addresses during the year as follows:

At Cookstown, in June, an afternoon address before the Farmers' Institute on Tillage, and an evening address before the combined Mens' and Womens' Institute, on the Climate of Canada.

At Guelph, before the Teachers' Association, an address on the Climate of Canada.

At Toronto, before the Ontario Fruit Growers' Convention, a report of the Experimental Shipment of Fruit to Winnipeg.

At St. Catharines, before the Niagara Peninsula Fruit Growers' Association, a report of the Experimental Shipment.

In June I was enabled, through the liberality of the Minister, to visit the Department of Agriculture at Washington. In visiting Washington, I had two objects in view: I wished to examine in detail the method in use at the division of Soils for the mechanical analysis of soils; and to exchange views with the division of Pomology respecting experimental work in Cold Storage of Fruit. At each of these divisions I met the greatest of kindness and courtesy, and found Mr. Briggs and Mr. Powell, with whom I had the most to do, willing to afford me every assistance in gathering information. At the division of Soils I was enabled to follow through a complete soil analysis, and have since put into operation in our own laboratory the method used there. We have now a complete, accurate, and rapid method of soil analysis in place of the old method, which was slow, laborious, and cumbersome. In detail, the method consists in drying a quantity of the soil at a temperature

of 110 degrees C, then weighing out a definite quantity and sifting this through a 2 millimeter sieve to remove the gravel. What passes through the sieve is known as fine earth, and from this fine earth 5 grams are weighed out, and put into a flat 8-ounce bottle, with about 2 ounces of distilled water and a few drops of ammonia. Eight soils are treated in this way, and the eight bottles placed horizontally in a shaker, and are then shaken for about ten hours. A small electric motor with the aid of a pulley-frame for reducing the speed runs the shaker. After shaking, the soils, with the water, are placed each in a test tube in the frame of a centrifuge, and the soils are whirled for three minutes by means of another electric motor, to precipitate the sand and the silt. What remains in suspension after the whirling is clay, and is poured into the sink, the amount of clay in each sample being determined by difference. The test tubes are filled again with water, the soil stirred up, and this operation is repeated until at the end of three minutes' whirling the water in the test tubes stands clear. Thus one constituent, the clay, is separated. Next, the test tubes are transferred to a rack, and filled in turn with water under pressure poured through a small glass nozzle. If the eight tubes are filled at the proper rate, after the filling of the eight, the water in the first, with the soil suspended, may be poured off into a beaker. The time between filling and decanting is determined by taking a sample from the first tube next the bottom, after the eight are filled, and examining this sample with the micrometer. If the largest particles are .05 millimeter in diameter, the time allowed for settling is right, and the operation may be repeated until, when the eight have been filled, the first stands clear. The sample contained in these decantings is silt, which is dried and weighed.

The final operation consists in drying the residue at the bottom of the test-tubes and sifting through fine sieves and bolting cloth, which gives the different grades of sand. Eight samples of soil can be analysed daily by this method.

At the division of Pomology I was given the benefit of the experience gained there in the cold storage of fruit. My particular object, however, was to gather some information respecting shipment of fruit in cold storage, and I succeeded in gaining many valuable suggestions that I have since put into practice in the experimental shipment of fruit to Winnipeg. The business arrangements came under consideration—the terms by which the fruit is secured from the growers; the kinds of car used; the means by which proper transportation is secured; the details that should be noted in reporting the condition of the fruit at the shipping point and at the market; and the results obtained in shipping various kinds of fruit various distances.

Lightning Report.

The amount of damage by lightning in 1904 exceeds greatly that of the previous year. The following analyses present the results of our reports for the four years, 1901-1904, inclusive:

	Elm.	Pine.	Oak.	Basswood.	Maple.	Ash.	Poplar.	Apple.	Hemlock.	Willow.	Beech.	Chestnut.	Balsam.	Hickory.	Butternut.	Total.
1901	7	8	1	5	2				2			1				26
1902	6	1	5	2	4	2	1			1	1		1	1		25
1903	5	3	1			1	1	1		1						13
1904	6	4	1			1	2	2							1	17
Total	24	16	8	7	6	4	4	3	2	2	1	1	1	1	1	81

	Animals struck.					Buildings struck.	
	Cattle.	Sheep.	Horses.	Hogs.	Total.	Barns.	Other buildings.
1901	33	7	11	1	52	26	6
1902	22	47	17	3	89	39	19
1903	8	1	2	.....	11	24	8
1904	32	9	8	.....	49	62	19
Total	95	64	38	4	201	151	52

The number of barns reported as struck this year is sixty-two, of which thirty-three have reported losses. The total loss of barn property reported is $82,450, making an average loss of $2,500. These figures, of course, refer to barns completely burned, in most cases with part or the whole of the season's crop. Of the sixty-two barns reported as struck, fifty-four were completely burned. Applying the above average loss to these fifty-four, there is the enormous total of $135,000 loss in Ontario from the destruction of barn property alone by lightning, and these figures do not represent the total loss, since our reports are necessarily incomplete, and the eastern part of the Province is not nearly so well reported as the western part.

Of the total number of reports received, most of them were obtained from newspapers, and full particulars as to circumstances were not obtainable. We obtained, however, nineteen complete reports of barns struck. Of these nineteen, sixteen were isolated, with no trees or buildings near. Of the sixteen, fourteen were burned. Only one of the nineteen is reported as being situated near high trees, and this one was near some poplars, and was slightly damaged. Of the whole sixty-two reports, no mention is made of the buildings being rodded. Of the nineteen complete reports, none of the buildings was rodded. In one instance a windmill over the barn was struck first and the current side-flashed into the building from this source, and the building was burned.

In my previous reports under this head I have called attention to the evident effect of trees in protecting farm buildings. While there is no absolute proof, either from this year's reports or from previous years, there is in all of them strong presumptive evidence as to the efficiency of this means of protection. The planting of trees, such as spruce, elm, or maple, near enough to buildings to protect them, but not so near as to endanger them, is strongly recommended. The trees should be planted at such distance that when full grown their branches will not touch the buildings.

The electric storms this year seem to have been unusually destructive of human life. Sixteen persons are reported as being struck by lightning, of whom thirteen were killed outright. Five of these who were killed were standing under trees and two were in houses. The danger of accident to persons standing under trees during an electric storm ought to be sufficiently evident to prevent the recurrence of this exposure. It is certainly very unsafe to seek refuge of this sort during thunderstorms.

Forty-nine animals are reported killed, with a total estimated loss of $2,010. Of the forty-nine, twenty-five were under trees, and nine were standing in the open field. One is reported as near a wire fence; three in a bush; with the remainder the circumstances are not specified.

Of the various dates on which storms occurred, two stand out most prominently: July 27-28 and August 13-14. Either these storms prevailed only in Western Ontario, or our reports from Eastern Ontario are sadly lacking; at any rate, in both of these the destruction reported is west of Toronto. The territory covered by the storms on these dates is as follows:

July 27-28.—Grey, Bruce, Perth, Wellington, Oxford, Simcoe, Elgin, Welland.

August 13-14.—Peel, Halton, Wentworth, Elgin, Waterloo, Oxford, Wellington, Lambton.

I wish to thank all those who have assisted in the collection of these reports. The practice has been to send out blank forms to ex-students of the College and to many others who have signified a willingness to report occurrences of loss or damage by lightning. This year, in addition to this source, we have been aided greatly by the newspapers of the Province. At the beginning of the season I sent circulars to the various newspapers of Ontario, requesting that a sample copy of papers containing lightning reports be sent to this department. Many of the papers have very kindly assisted in this way, and thus I think our reports are more complete than in previous years.

The Shipping of Fruit to Winnipeg by Freight.

In September of this year I arranged for the loading of two cars of fruit, one at St. Catharines and one at Grimsby, to be shipped to Winnipeg by freight. The varieties of fruit were: Peaches, plums, grapes, pears, apples, and tomatoes. The object of the shipment was particularly to find out how, under the best conditions of packing, loading and icing, certain tender fruits would carry from Southern Ontario to Winnipeg. The secondary objects of the shipment were: to examine into the whole question of handling the fruit at the shipping point, the question of transportation, and that of marketing.

At the shipping point boxes were used exclusively, the bushel box for apples, the half bushel box, 5x11x20 inches, for pears, and a box of similar dimensions for peaches—the pears in most and the peaches in all instances being wrapped in paper. Grapes were shipped in a Wilson crate, consisting of a bushel box containing 12 cardboard trays holding about 2½ pounds each. Plums were shipped some in this crate and some in a 2-basket crate, consisting of two 10-pound baskets enclosed in a strong container.

The cars were loaded after the California method, by placing the packages on their sides in a row across the car with spaces between the boxes about an inch wide. Across the top of the row along each end was nailed a strip which butted against the sides of the car and was nailed securely to each package, the nail passing through the wooden strip and into the head of the package. This was repeated, row above row, until a tier was completed as high in the car as we wished to go; then another tire was placed in the same fashion butting against the first. Thus each box was held rigidly in place and between the boxes there was an opportunity for circulation of air.

The time of transit was for the first car eight days, and for the second car seven days. The fruit without exception arrived in good condition. The prices obtained were as followed: XXX Crawford peaches 85 to 90 cents net, after deducting for freight charges, commission, and cost of the package; plums, in terms of the 11-quart basket, 47 to 54 cents net; grapes, in terms of the 11-quart basket, 40 to 50 cents net; pears, per box, realized as high as 83 cents net, although some sold very much lower on the second day; apples, 40 to 50 cents a bushel for well-colored varieties, 25 to 30 cents for others. These prices are all for XXX stock.

Summary.

1. The Western market demands well-colored and well-matured fruit.
2. Both in appearance and in prices, Ontario peaches, if allowed to mature properly on the tree, compare favorably with California peaches on the Winnipeg market.

3. California and British Columbia, although at a much greater distance than Ontario, are fast getting a monopoly of the Western market.
4. Owing to tariff and higher freight charges, California peaches, in competition with Ontario peaches, suffer a handicap of 40 cents a box.
5. In carload lots, freight rates to Winnipeg, including icing, are little more than one-third express rates. Quickly ripening fruit is safer in a good refrigerator car for six or eight days than in a hot unventilated express car for three days.
6. Transportation ought to be no hindrance to a large expansion of trade in tender fruits between Ontario and the Northwest. Peaches, plums, grapes, and Bartlett pears, well-matured, carried safely with eight days' transit. A transit of five days over the same route is frequently accomplished, and is quite practicable.
7. Our fruit is at a disadvantage in the market because of the general lack of uniformity, neatness, and skill displayed in grading and packing.
8. A uniform size and style of package is very desirable. So far as possible, all box packages should be of the same length and width, and should vary in depth to suit the character of the fruit.
9. So far as rapid cooling and safe shipping in cold storage are concerned, the barrel is suited to winter apples, the bushel box, 10x11x20 inches, to early fall apples and winter pears, and the half bushel, 5x11x20 inches, to peaches and early pears.
10. The basket carries grapes and plums satisfactorily, but, for safety, it should be enclosed, as in the Georgia 6-basket carrier, or the 2-basket carrier.
11. To remedy existing defects in all departments of the fruit trade, and to put it on a secure footing, the co-operative plan should be adopted, including a central packing house, the employment of expert packers, and an organization capable of overcoming obstacles.

Remarks on the Experiment. While at Winnipeg I took the opportunity of observing the class of fruit on the market there. I found displayed in the shop fronts peaches from California and Idaho, grapes and pears from California, but, up to the time of the sale of our two lots of fruit, no Ontario peaches could I see in Winnipeg, very few grapes and very few pears. On the way home at Allandale I noticed on the station platform a fruit stand, and this stand bore the California pears and California grapes, but no Ontario fruit. At Guelph, upon my return home, there again I saw California fruit with its well-known style of package displayed in some of the stores. This state of things is not in keeping with the fact that in Ontario we can produce the very best quality of these classes of tender fruits. True, while there is no excuse for foreign fruit being found on our local markets at the time of the year when these fruits are fully in season in Ontario, yet there are undoubtedly obstacles to a trade with Manitoba and the Northwest Territories. These obstacles are, as represented by our fruit-growers: First, our fruits are not of good shipping quality; secondly, transportation is not satisfactory; thirdly, markets are uncertain and commission men and others who handle our fruits do not always give satisfactory returns. With respect to the first of these, namely, the good shipping quality of our fruit, we have up to the present underestimated this quality. Our fruits, if properly handled at the shipping point and in transportation, ship very much better than is generally understood. As to the other obstacles, transportation and markets, there is undoubtedly much room for improvement, and it was the object of this particular shipment, not only to investigate the shipping quality of our tender fruits, but also to make a full inquiry into the transportation and market conditions that surround our fruit trade.

Defects at the Shipping Point. My conclusion, after following out this experiment from the very beginning, examining the fruit offered at the shipping point, following the cars to their destination, and examining the fruit again at the market, is this: that the greatest obstacle in the way of a complete success in shipping fruit to distant points is to be found at the shipping point itself, and conditions there must be entirely altered before any degree of success can be looked for in this business. Ontario fruit-growers have exhibited a large degree of intelligence and skill in selecting the varieties suited to their soil and climate, in battling with pests of all kinds that have invaded their orchards, and in cultivating and improving their soils. For the intelligence and enterprise displayed in this direction our fruit growers deserve great credit, and it is no discredit to say that their time and attention have been so fully occupied with these things that they have not as yet given the needed attention to the matter of marketing their fruit. But it is the marketing of the fruit that is now defective, that is to say the selecting of the fruit of proper degree of maturity, grading it in uniform sizes, using proper styles of package, packing neatly and effectively; and toward these things the fruit-growers must direct their attention before success can be achieved.

Proper Degree of Maturity. To mention some of the particulars in which improvement should be made, I might begin with the selection of fruit of the proper degree of maturity. The impression prevails largely that in order to ship tender fruits to a distant market, requiring five, six, or more days in transit, these fruits must be picked hard and green. The results of our experiment, as well as those of experiments conducted on a large scale at Washington, point definitely to the conclusion that all fruits should be left on the tree until they have attained their characteristic size, color, and flavor, but should be, for distant shipment, picked in advance of dead ripeness. It is evident, then, that the matter of picking the fruit from the tree is one requiring more or less expert knowledge, and should not be left to irresponsible and uninstructed persons. For apples and winter pears, the period when picking may properly be done is apparently a wide one. For quickly ripening fruits, such as peaches, plums, early pears, or early apples, the period when the picking of any particular specimen should be done is a narrower one, covering, perhaps, not more than a day or two, and the trees should be gone over as frequently as this and the mature specimens removed. If fruit is picked before it has attained its size or color or flavor, it will never develop these off the tree. If picked later than this critical period, the fruit is dead ripe, and, while suited to immediate consumption, will not ship any distance. For any purpose whatever fruit should not be picked before this critical period arrives. There is nothing to gain and much to lose by premature picking. It is doubtful even if fruit will hold much longer when picked in the green and immature state than when picked at the proper degree of maturity. Even if it does hold some what longer, it is not worth while, it is detrimental to the reputation of our fruit, to ship stuff to distant markets immature and undeveloped. If upon being picked at the right time, fruit will not ship to any particular point, then it is the business of the fruit-grower to exploit markets nearer home.

Packages. Much improvement may be made in the second place in selecting packages of correct size and shape for shipping the various classes of fruit. If a freight business to the Northwest is to be made a success, it must be in carload lots, and I believe that for the present at least small lots of each kind will yield better prices on the Winnipeg market than a carload lot of the same kind of fruit. Therefore, shipping carloads of mixed fruits will likely receive the attention of the fruit-grower in the immediate future, and for this purpose packages of some uniform shape should be adopted, so

that whether apples, or pears, or peaches are shipped, the packages will fit together in the car. This end can readily be gained by using, for fancy apples and winter pears, the bushel box already adopted by the Ontario Fruit Growers' Association, 10x11x20 inches; for early pears and peaches, a box one-half this size, 5x11x20 inches; then for plums and grapes, the bushel box with open sides for ventilation, containing six 4-quart baskets, after the pattern of the Georgia peach carrier, may profitably be adopted. If these suggestions are followed, we shall then have, for all classes of fruit, packages which will fit together in the car, and which, furthermore, are suited to the character of the fruit. It must be borne in mind that in selecting a package the principal consideration is, for quickly ripening fruits, the rapidity with which the fruit can be cooled when placed in cold storage, throughout the whole body of the package. It is important that fruit, such as peaches, plums, and early pears, should be cooled as quickly as possible to a temperature of 40 degrees, or thereabouts, and for this purpose a shallow package, say five inches in depth, will cool in about one-half the time which is required by the bushel box of the same length and width but 10 inches deep.

Packing. The next particular that requires careful attention at the shipping point, is the matter of packing the fruit, including grading to uniform size, the use of fillers, and wrapping paper. Of grading nothing need be said here, for the importance of it is surely understood by all, apart altogether from the legal aspect of the question. In packing, the first essential is that the fruit be packed tightly, allowing no room for jolting about in the package during transit. Many packers try to make up for looseness in packing by the use of fillers, such as paper and excelsior. While small quantities of these may be used occasionally with propriety, yet I am inclined to say that in our two shipments altogether too much of it was done, and the fillers were made to do duty for careless packing and want of proper selection of fruit. As to wrapping paper, all peaches and most varieties of pears will pay for wrapping, and the manila paper of medium weight is preferable to the thin light tissue paper which is sometimes used. Paper with some strength and consistency will take the pressure and strain which otherwise would fall upon the tender skin and flesh of the fruit. In the selection of a wrapping paper, it should be of a size suited to the size of the fruit, so that when the fruit is surrounded by the paper there is just enough left to turn over and to cover the fruit all around. Anything larger than this is objectionable.

Freight and Express Rates. If by means of careful attention to these particulars at the shipping point a freight trade between Ontario and the Northwest in tender fruits can be established, it will mean a great deal to the Ontario fruit-grower. Between freight and express, fruit properly packed and loaded is safer in the refrigerator car for six or eight days than it would be in the hot unventilated express car for three days, and in the matter of charges, freight rates are a trifle more than one-third of express rates, in carload lots. For instance, the express charges on a box of peaches from Southern Ontario to Winnipeg are 42 cents, the freight rates 14.8 cents; for a box of pears of twenty-five pounds, express rates are 52 cents, freight 18½ cents.

It is evident to all who have made a careful study of this question that the various difficulties in the way of establishing this business can be overcome for the average fruit-grower in no other way than by co-operation. Co-operation will give the fruit-growers strength to deal with the railway companies, to compel from the latter proper regard for their rights, and, furthermore, the added business which would result from co-operation would make it appear to the railways more and more worth while to give the matter of fruit transportation the attention it will then deserve. Also, the strength of

an organization will be able to grapple successfully with the problems of marketing, which at present it is difficult, if not impossible, for the private shipper to do. Then at the shipping point the co-operative concern will take charge of the whole business of selection of the packages, grading, packing, and shipping of the fruit, thus relieving the individual fruit-grower from the necessity of attending to these exacting details, and giving him time to attend to his legitimate business of producing prime fruit.

Some Notes on Dimensions of Packages in Relation to Cooling.

The question of size and shape of package to be used in shipping or storing any particular variety of fruit is highly important: important not merely in respect of cost and convenience of package, or the degree of firmness of fruit that will sustain the weight of the fruit above it in the package; but important more especially on account of the rate at which the whole of the fruit in the package will cool to the temperature of the refrigerator. Slowly ripening fruits, such as winter apples and winter pears, may be safely packed in a case that cools slowly. But quickly ripening fruits, to be preserved, must be cooled very quickly to a temperature of 40 degrees or below, in order to delay the ripening and decaying processes. With a peach that will ripen and begin to decay two days after picking, a few hours' delay in cooling will make relatively a great difference in the length of its life. For such fruits as this, a package must be used that allows the most rapid rate of cooling.

With these principles in mind, the following temperature tests were made at the Cold Storage Warehouse at the Agricultural College. Four packages were filled with apples, and long thermometers were inserted in the midst of the fruit, the bulbs being at the centres of the packages and the stems and reading scales standing out of the packages in view of the observer. The packages were then headed, placed in a warm room and kept for a week until they reached a uniform temperature of 64 degrees F, and then were transferred to a room in the warehouse that is kept at a temperature of 32 degrees to 34 degrees. The packages were:

(1). An ordinary large apple barrel.

(2). A bushel box 10x11x20 inches, with close joints practically air-tight.

(3). A Georgia peach carrier 10x11x20 inches, with open spaces at sides; the fruit within was packed in the 6 baskets and among these baskets were empty spaces permitting circulation of air.

(4). A half-bushel box 5x11x20 inches, with open spaces at sides, bottom, and top.

Result of Temperature Test.

Package.	Times of observation.	Amount of cooling.
(1)	a.m. p.m. hours	
Barrel	10.30—2.00, 3½	64.5—60.5 = 4°
Bushel (closed joints)	" " 3½	64.5—57.5 = 7°
" (open)	" " 3½	64.5—54 =10½°
Half bushel	" " 3½	64 —51 =13°
(2)	p.m. p.m. hours	
Barrel	2.00—8.00, 6	60.5—57 = 3½°
Bushel (closed joints)	" " 6	57.5—50 = 7½°
" (open joints)	" " 6	54 —43 =11°
Half bushel	" " 6	51 —40 =11°
Total.	a.m. p.m. hours	
Barrel	10.30—8.00, 9½	64.5—57 = 7½°
Bushel (closed joints)	" " 9½	64.5—50 =14½°
" (open joints)	" " 9½	64.5—43 =21½°
Half bushel	" " 9½	64 —40 =24°

The half-bushel, it may be seen, had cooled to a sufficiently low temperature, 40 degrees, in 9½ hours; the Georgia crate, with open sides and open packing, cooled in the same time within 3 degrees of that temperature. By the next morning at 8 o'clock the half-bushel had cooled to 35 degrees, the Georgia crate to 35 degrees, the bushel to 39 degrees, and the barrel to 47 degrees. Two days after the commencement of the observations the barrel was still at a temperature of 38 degrees, 6 degrees above that of the room.

The application of these facts is obvious: Winter apples and winter pears may, so far as temperature and ripening are concerned, be packed in barrels. For winter pears, no package smaller than the bushel box need be used. Between the half-bushel and the bushel, there was in the above test a difference of 12 hours in cooling from a temperature of 64 degrees to 40 degrees; but this difference is insignificant with slowly ripening fruit.

For summer and early apples the barrel is too large a package, and much of this fruit shipped in barrels turns out badly by reason of the slowness of cooling. Where decay occurs it is usually at the centre of the package, because this is the last to cool. The bushel box, cooling at the centre in half the time that the barrel requires, is for this reason preferable to the barrel for early apples.

For early and quickly ripening pears, the bushel box is too large a package for best results in long shipments, unless it be in the form of the Georgia carrier with open sides, when it resolves itself virtually into a number of smaller packages with spaces between. The writer chanced to call upon a retail dealer at Winnipeg and found him unpacking some Ontario pears, Bartletts, from bushel boxes. There was a marked difference between the pears next to the package and those at the centre. Those at the outside were still green and firm, while those at the centre were quite ripe, and many of them soft and pulpy. The use of the half-bushel box in this instance instead of the bushel, would have hastened the cooling of the centre of the package by 12 hours, and would likely have preserved the fruit at the centre.

All results of storage and shipping experiments concur in pointing out the necessity for quick cooling of tender fruits. Such fruits should be packed in shallow cases, and placed in a cold store as soon as possible after picking.

Observations at American Colleges.

I append herewith a report of some observations made by Mr. W. H. Day, Demonstrator in Physics, during a visit at some of the American institutions:

Early in the summer of 1904 I was privileged through the kindness of the President to visit several American Colleges of Agriculture to observe their methods of instruction and investigation, especially in physics of the soil. A few days were spent at each of the following places, in the order mentioned: Michigan Agricultural College, Lansing; Chicago; Wisconsin College of Agriculture, Madison; Iowa State College, Ames; World's Fair, St. Louis; and Illinois College of Agriculture, Urbana.

The organization and instruction in the various departments of agriculture at these institutions vary considerably. At Michigan the pure physics is taught by the department of Physics; the applied Physics by the department of Mechanics; and the Soil Physics, by the department of Agronomy. Students in agriculture take the elements of pure physics during their first and second years. In the department of Agronomy their first year work consists of a study from simple experiments of the effect of soil temperature and aeration upon germination and growth of plants; also tillage and drainage. Farm Mechanics is studied during the sophomore year. The third year is devoted to a study of the history and work of the Agricultural Department at

Washington, and to various problems for investigation, one to be solved by each two students. In the fourth year investigation is again carried on, preferably a continuation of work begun or suggested during the previous year. An extensive course in soil physics, soil mathematics, soil thermometry, evaporation, and soluble salts of the soil completes the physics of the course.

Prof. Jeffery, who with Prof. Shaw has charge of the work in Agronomy, was investigating the effects of manures in different quantities on the temperature of the soil at various depths. Also the validity of the conclusions reached in bulletin No. 22 of the Division of Soils, was under investigation.

The University of Wisconsin was in the midst of its jubilee festivities when I arrived there, so that the opportunities for observing the work here done were not so good as they otherwise would have been. In the intervals, however, Prof. Whitson found time to give me a pretty full idea of the work being done by the department of Soils. The green-house constitutes a special feature of the equipment of the soils department. A large green-house 70 feet by 42 feet is devoted to the work. It is divided into three sections, one consisting of shelves and tables for pot cultures; a second is furnished with 108 cylinders 4 feet deep, some 18 inches, others 36 inches in diameter, for experiments in soil fertility and tillage; the third is an open space for experiments in levelling, ditching, etc. To a question as to whether or not the space available was sufficient Prof. Whitson replied: "Where it is possible to divide the class into sections of twenty or twenty-five each, the space is sufficient, otherwise there would be crowding."

The students in the short course do no laboratory work in physics, and the instruction is of a strictly practical rather than a theoretical nature. The first two years of the "long course" are taken in the College of Letters and Science. The physics of those two years comprises the elements of general physics. The third year is devoted to (1) a study of the origin and classification of soils, and of the effect of their physical, chemical, and biological conditions upon the growth of plants; (2) a course of drainage, irrigation, and cultivation, with field and laboratory work; (3) climatology, a study of the distribution of heat, light, and precipitation and of their influence on soils and crops. In the fourth year the students take up advanced and original work in the origin and fertility of soils and their practical management.

In Iowa State College a department of Soils has been recently founded, which, under Prof. Stevenson, is doing good work. During the first two years a foundation in general physics is laid, but during the third year great stress is laid on soil physics and soil fertility, five periods a week being devoted to the subject during the entire year. This is equivalent to three lectures of one hour each and two laboratory periods of three hours each. Each man writes four essays, two on soil physics and two on soil fertility, during the first half of the year; during the latter half his laboratory periods are spent in research on some soil problem. For the research work in Soils, two fine green-houses, 20 ft. by 30 ft. with soil store-rooms attached, have been provided. In these, by means of pot cultures, the students investigate such problems as: The relation of legumes and the different species of bacteria; or the effect of different elements of plant food.

The field work done by the department of Soils is a special feature. A large number of 1-10 acre plots have been laid out. On any particular plot a certain combination of fertilizers will be sown from year to year; on another plot another combination, and so on. These plots are laid out in quadruplicate, and a four year rotation of oats, oats and clover, corn, and corn will be studied. Different methods of tillage are also tested. In this way the best methods of fertilization and tillage for such a rotation will be arrived at.

The teams necessary for the tillage of these plots belong to the department of soils.

The soil laboratory in the Education Building at the Fair was not in full operation—gas and water connection were still lacking—but the most approved apparatus from the leading Agricultural Colleges throughout the Union was on exhibition. Rough sketches were drawn of several pieces, some of which have already been placed in our laboratory, e.g. apparatus for tamping soil; also for testing the resistance of soils when puddled and dried.

Urbana, Illinois, was the last place visited. In Illinois $25,000 is spent annually in soil work. A soil survey of the whole state is being made. Survey parties visit different sections, mapping and sampling areas as small as 10 acre fields. The samples are analysed by chemists and physicists. In every type of considerable distribution pot cultures are made, also 1-10 acre plots are laid out and treated in various ways, both for tillage and fertilization. Eighteen such local experimental farms are in operation under direction of the experiment station at the College.

The instruction in soils is similar to that in the other Colleges visited; during the second year, soil chemistry, during the third, soil physics, soil moisture, and capillarity, and during the fourth soil fertility.

Here, as at both Ames and Madison, soil green-houses were provided for the work of the department. The outstanding inference from the observations made is that if we in Ontario are to keep pace with the advancement our neighbors are making in soil work, we must be provided with green-house and equipment therefor. Many interesting problems await solution—problems that can be solved only when plants can be grown under controllable conditions. The green-house furnishes the means of doing so.

Weather Report, 1904, at the O. A. C., Guelph.

——	Jan	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	o	o	o	o	o	o	o	o	o	o	o	o	o
Mean temperatures	11.6	9.3	25.7	34.0	53.3	62.5	65.7	64.0	58.2	4.49	33.5	18.5	40.1
Departure from normal	— 6.4	— 6.3	— 2.5	— 7.7	— 1.1	+ 0.2	— 3.3	— 2.0	— 2.1	— 3.5	— 1.6	— 3.0	— 3.0
Lowest temperatures	—25.0	—19.0	0.0	17.0	34.0	41.5	42.0	42.0	30.0	20.0	4.0	1.0	—25.0
Highest temperaturee	38.0	51.0	49.0	62.0	83.5	84.0	90.25	84.0	81.5	72.0	54.0	44.0	90.25
Precipitation in inches:													
(Rain and melted snow)	0.85	2.54	1.44	2.10	3.01	2.86	4.99	3.88	2.80	2.04	0.10	2.06	28.66
Departure from normal	—0.67	+0.82	+0.14	+9.13	+0.59	+0.09	+1.18	+1.54	+0.26	+1.03	—1.28	+0.47	+2.26

Year.	Mean temp.	Date of last frost in spring.	Date of first frost in autumn.	Length of period without frost.
1899	42.1	May 15	Sept. 23	130 days
1900	45.6	May 10	Oct. 17	158 "
1901	43.1	May 15	Oct. 4	141 "
1902	43.3	May 11	Oct. 2	143 "
1903	44.4	May 5	Sept. 29	146 "
1904	40.1	April 22	Sept. 22	153 "
Average	43.1	May 8	Oct. 1	145 "

The weather of the year 1904 has been marked by large departures from the normal, both in temperature and in precipitation. The mean temperatures for January and February were over 6 degrees, and for April 7 degrees, below normal, and every month of the year but one fell below normal. The mean temperature for the year is 3 degrees below normal. Not only have

mean temperatures been unusually low, but for the winter months much lower minima than usual were reached: In January a minimum of —25 degrees in February —19 degrees, and in March 0.0 degrees. The total precipitation for the year amounted to 28.66 inches, an excess over the mean of 2.26 inches. In nine months of the twelve the precipitation was larger than usual, the greatest excesses occurring in July and August, while October and November were unusually dry. This report for Guelph represents fairly well the conditions over Ontario. For the winter somewhat more snow fell than usual over Ontario, although at Guelph less than usual. On account of the extremely cold weather, most of the snow that fell stayed, except in the extreme south. Generally, therefore, there was a larger accumulation of snow. But from Toronto westward along the lake shore, through the Niagara peninsula and in the Lake Erie district, the early snow thawed and formed a coat of ice, which was destructive to fall wheat and strawberry plants. Where the snow stayed, these crops wintered well.

The low temperatures of the winter played havoc with fruit trees, vines and berry canes. Peach and plum trees suffered severely, as well as some varieties of grapes and of apples, from root-killing. The past winter has proved the efficiency of cover crops as a means of protecting the roots of the trees. The continued cold of March and April was rather favorable to fruit, since it delayed growth and budding, and saved the trees and vines from further set-backs that might have resulted from late spring frosts. After the spring once set in, no late frosts occurred, and May and June were fairly warm.

The season as a whole has certainly demonstrated the climatic necessities of many of our most important crops. The crop of peaches was small, and plums were almost a failure. Grapes were a good crop, but the cool season failed to ripen them at the usual time and many were caught by the early autumn frosts. All fruits were ten days or two weeks late in ripening. The season was too cool and wet for corn, and a poor crop generally is reported. Oats, wheat, and barley generally did well, and they have shown their adaptibility to a wide range of climatic conditions.

We are reminded that Southern Ontario is the northerly limit for such crops as corn, peaches, and grapes, and that a slight lowering of the annual temperature will put these important products to great hazard. The fact is enforced that we must exercise every precaution in the selection of varieties, locations, and soils, and in cultivation and protection, so that these foster crops that originally belonged to a warmer climate, may continue to justify our experiments in transplanting them into the midst of the strenuous climate of Ontario.

Investigations.

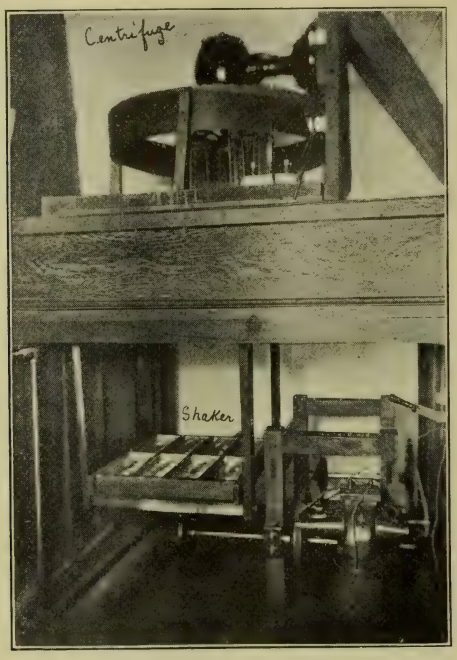
This department has under way the following lines of investigation:

Cold Storage of Fruits. This investigation is conducted in co-operation with the Department of Horticulture, and has been continued for two years. It is expected that a report of the work will be published shortly.

Soil Temperature at Different Exposures or Slopes. Daily observations were made of temperatures on a western slope and on level land, throughout the season. No report is being made on this work, as it has been decided to continue it and to confirm conclusions before publishing. The observations of soil temperatures at different depths has been continued, but the results are not reported here, and are being held over to make part of the general report on soil temperatures.

About seventy-five samples of soil, particularly from New Ontario have been sent to this department for analysis. Some of these have

been analysed, and as soon as the work is completed it will be made public in some form. We aim ultimately to obtain a soil map both of Old and New Ontario, particularly of New Ontario, so that the agricultural capabilities of new sections may be known before hand without experimenting on the part of the settlers. We hope soon to have this information available, and last year were working with the Crown Lands Department for the collection of soil samples from the newly surveyed areas in New Ontario.



Soil Analysis (See page 23).

Extension of the Work in Soil Physics.

Early this year an arrangement was reached for the readjustment of the work in Agriculture. The department of Physics has taken over part of the instruction in field agriculture formerly given by the Agriculture department. This addition of work will be distributed over three years, the First, Second and Fourth Years. In the First Year we aim to take the subject up as practically as possible with a view to studying the principles of the tillage of the soil, the control of the moisture, heat, and air supply, and the soil texture. This will include a consideration of the uses and adaptabilities of different implements to the various operations in the field. In the Second Year the work of drainage will be considered, principally the value of drainage and the engineering methods of installing a system of drainage. In the Fourth Year the science of soil physics will be considered more in detail and the practical questions of tillage and drainage will be enlarged and extended.

Respectfully submitted,

J. B. REYNOLDS.

PART IV.

THE PROFESSOR OF BIOLOGY AND GEOLOGY.

To the President of the Ontario Agricultural College:

SIR,—I have the honor of presenting herewith my Seventh Annual Report on the work done in the Biological department.

As in previous years, the duties of this department may be grouped under three heads: (1) Instruction; (2) Outside work, including correspondence and the preparation of special articles for the press; and (3), Investigations regarding weeds, fungus diseases, and insects.

I. INSTRUCTION.

The major part of the time of myself and my assistants has been occupied during the past year in the work of instruction; in fact never since I assumed charge of this Department has our time been so fully occupied with the instruction of classes. It is gratifying to know, however, that the students and graduates of this college are not satisfied merely with the so-called practical aspects of agriculture, but are demanding a good, firm foundation in the sciences upon which they are able to build a solid superstructure. The very thorough courses in biology, physics, and chemistry are, I believe, responsible largely for the splendid work achieved by our students in the later years of their College course and after they leave College. Courses in Biology are thoroughly practical, and emphasize the practical side of instruction.

Following is a brief synopsis of the regular courses given in 1904 in Botany, Entomology, Zoology, and Geology:

BOTANY, *First Year.* (a) Field excursions, where the student familiarizes himself with the names of the common wild plants, learns their manner of growth, and the ways the fruit and seeds are produced and disseminated; (b) Laboratory studies of the entire plant, including root, stem, leaves, flowers and fruit; and (c) Lectures summarizing and illustrating the practical work—by Mr. Hotson and Mr. Jackson.

BOTANY, *Second Year.*—(a) Field excursions and laboratory studies in the morphology of plants, especially those plants of economic importance, and their classification; a critical study of weed-seeds, and an elementary course in the study of grasses and fungi; (b) Lectures (two every week) on the morphology, classification, and physiology of plants,—by Professor Lochhead, Mr. Jarvis, and Mr. Jackson.

BOTANY, *Third Year.* (a) Laboratory and lecture courses in systematic botany, including grasses—by Professor Lochhead; (b) Laboratory and lecture courses in Structural Botany—by Mr. Thompstone; (c) Lecture and laboratory courses in plant physiology—by Mr. Hotson.

BOTANY, *Fourth Year.* Specialists in Horticulture. (a) Laboratory and lecture course in plant histology—by Mr. Hotson and Mr. Thompstone; (b) Laboratory course in fungi and plant pathology—by Professor Lochhead; (c) Seminary and practical course in plant physiology—by Professor Lochhead; (d) A laboratory course in the study of cultivated plants—by Mr. Jarvis.

Botany, *Fourth Year.* Specialists in Agriculture. Lectures and laboratory course in grasses and forage crops—by Professor Lochhead.

Entomology, *Second Year.* A course of thirty-five lectures, demonstrations and practical exercises. The chief insect pests of the farm, orchard, and garden are discussed and studied, under Professor Lochhead and Mr. Jarvis.

Entomology, *Third and Fourth Years.* This course, consisting of lectures and practicals, deals with both beneficial and injurious insects, and is a continuation of the second year course. Here the students become acquainted with the literature of the subject—by Professor Lochhead and Mr. Jarvis.

Zoology, *First Year.* This course consisted of lectures and practicals, thirty in all. The chief animal types from the Amoeba to Mammals are discussed and much attention is given to the Birds and Mammals of the farm—by Mr. Hotson.

Geology, *First Year.* A course of thirty lectures and demonstrations, dealing with the common minerals and rocks, the chief agencies operating in the formation of soils, and the geological history of the rock formation of Ontario—by Professor Lochhead.

Geology, *Third Year.* This course is a continuation of the first year course; but it is of a more practical nature, because the class is smaller. Considerable attention is given to the formation of soils through glacial action, and the geological history of North America is studied with special emphasis on the Canadian region—by Professor Lochhead.

Nature-Study. In addition to the courses outlined above, this Department directed three separate classes in Nature-Study. The first class, the Third Year students, was carried on from April 17th to June 1st (six weeks). Special out-of-door studies of spring vegetation, insects, birds, pond life, &c., as problems for investigation, were made by each student, who was required to make full reports, and to give an address before the remaining members of the class on some study he had completed. Mr. T. Otway Page, B.A., as in the previous year, conducted the work in Bird Study, and to him we are indebted for much of the enthusiasm displayed by the class. The second class, consisting of Public School Teachers, was conducted at the Macdonald Institute with the assistance of Dr. Muldrew, Mr. Jarvis, and Mr. Evans during July (four weeks). The studies were of a more elementary character, and were specially adapted for Public School Teachers who wished to introduce Nature-Study into their schools. The third class, composed of teachers from Prince Edward Island, Nova Scotia, New Brunswick, Quebec, and Ontario, was carried on from September 15th to December 15th (three months). On account of the untimely death of Dr. Muldrew, the burden of the work of directing this class fell upon Mr. Jarvis and myself. (See Report of Nature-Study Department of Macdonald Institute).

Weed Seeds. Instruction was also given by Mr. Jarvis to the Short Course Students in January last on *Weeds and Weed Seeds*, to the end that more attention be given to clean-farming. This course was a practical one, and every student was made familiar with the chief weed seed impurities that are liable to occur in alsike, red clover, and timothy.

Staff. During the year several changes were made in the personnel of the staff of this Department. The resignation of Mr. J. W. Hotson, M.A., in June to assume the duties of Principal of the Macdonald Consolidated School at Guelph, made it possible to promote Mr. T. D. Jarvis, B.S.A., to the position of Lecturer in Biology. Mr. V. W. Jackson, B.A. (Queens), was appointed Demonstrator to fill the vacancy caused by the promotion of Mr. Jarvis. On account of the large amount of extra work devolving upon this

Department in giving instruction in Nature-Study it became necessary to appoint another Demonstrator. Mr. J. W. Hagan acted in this capacity for six weeks, when he was succeeded by Mr. E. Thompstone, B.Sc. (Edinburgh). I wish to place on record the good work done by Messrs. Hotson and Jarvis, who have shown themselves as in the previous year, to be capable and painstaking instructors, and by Messrs. Jackson and Thompstone, the new members of the staff, for the zeal and enthusiasm which they have displayed in the conduct of the classes committed to their charge.

II. Outside Work.

The correspondence of the Department related mainly to the depredations of insects and fungi, about which inquiries were made by farmers, fruit growers, and gardeners.

Acting under instructions from the Deputy Minister and yourself, Prof. Harcourt and I carried out a series of experiments at St. Catharines for the purpose of testing the relative efficiency of the McBain Carbolic Mixture and the lime-sulphur wash, against the San José Scale. We also tested the new methods of preparing lime-sulphur wash by the use of sal-soda and caustic soda with the lime and sulphur without boiling. The results of these experiments will be found in detail in the Annual Report of the Entomological Society of Ontario for 1904.

Some attention was also given to a study of the Black Rot in a vineyard near St. Catharines belonging to W. H. Bunting, and in the vineyards of Northern Ohio, which I visited during the last week in August at the suggestion of the Minister of Agriculture. The results of my observations will be found in the Annual Report of the Fruit Growers' Association for 1904.

I gave an address before the West Middlesex Teachers' Association held in London, May 5th, on "Insect Life as a Nature-Study."

At the annual meeting of the Entomological Society of Ontario, held in London October 26th and 27th, I presented the following papers: "Injurious Insects of 1904," and "Some Recent Experiments with Lime-Sulphur Washes Against the San José Scale." I also delivered the President's address, taking for my subject: "Recent Progress in Economic Entomology."

At the annual meeting of the Fruit Growers' Association in Toronto, November 18th, I gave an address on the "Black Rot of Grapes."

I attended the annual meeting of the American Association of Economic Entomologists held in St. Louis on December 28th-30th, 1903, where I read a paper on "Some Injurious Insects in Ontario." I attended also, with your permission, the annual meeting of the same Association held in Philadelphia during Christmas week, 1904.

The Museum. As Curator of the Museum, I take pleasure in recording "progress" in the placing of exhibits during the year. *The Birds of Ontario* are now nicely arranged in the four new upright cases purchased this year, and are available for study by nature students. To Mr. A. B. Klugh, of Guelph, we are deeply indebted both for the arrangement of this valuable collection, and for the notes on the special cards beside the specimens, and I take this opportunity of calling your attention to the valuable work he has done. Already many visitors have expressed themselves as being well pleased with the educational features of the collection.

The Collection of Wax Fruits, modelled and colored by Mrs. Potter, under the supervision of Prof. H. L. Hutt, has been arranged very admirably by Prof. Hutt and Mr. Peart of the Horticultural department in five new flat cases. This collection, I need hardly say, is perhaps the most interesting of all to the general public, and it cannot fail to help our fruit-growers to a better naming of the varieties in their orchards.

Prof. Harrison has arranged in the south-west corner a very instructive *Bacteriological exhibit,* which gives the visitor some idea of the work done by the Bacteriological department for the advancement of agriculture.

The *collections of minerals and rocks* are not yet arranged for want of suitable cases. We need at least five more upright cases, and five more flat cases before we can display properly the many exhibits in our possession, as well as those promised by the Physical and Chemical departments. An appropriation of $1,000, is therefore urgently needed. An effort should be made during the coming year to procure material to illustrate the progress of agriculture in this Province in the matter of implements of tillage, etc. Such a collection would not only be interesting, but also instructive and valuable in future years.

The following additions were made to the Museum this year:

1. A collection of shells, &c., from Florida, presented by Mr. A. G. Reynolds, of Diston City, Florida.

2. A collection of woods and cones from California, presented by Roland D. Craig, B.S.A., F.E.

3. Diagrams of our native trees, with frames made from the wood illustrated in diagram.

Articles Contributed to the Press, and Special Pamphlets. "The Plum Rot," "The Raspberry-Cane Borer," "School Gardens for Teachers," "Black Rot of Grapes in Ohio," "An Apple Tree that has Died, and Why," for the Canadian Horticulturist: "Fall Cleaning in the Orchard," as a Press Bulletin, (October); "Advantages of Nature-Study in Rural Schools," for the Farmers' Advocate, (October); "Black Rot of Grapes," and "Nature-Studies," (Editing) for the O. A. C. Review.

Two pamphlets entitled "Outlines of Nature Studies" were printed for the use of the Classes in Nature-Study. The first pamphlet contained studies suitable for spring investigation; the second, studies suitable for autumn.

In the preparation of Bulletin 134, entitled "Hints on Making Nature Collections in Public and High Schools," by Dr. Muldrew, I contributed the sections dealing with Insects and Aquaria.

Our Needs. We are deeply grateful for the commodious laboratories placed at our disposal, for we are able to do more efficient work at a smaller expenditure of time and energy than in previous years. On account, however, of the growing importance of a practical knowledge of insect and plant life it is necessary that a building in the form of a greenhouse should be provided, so that the conditions can be controlled at all seasons. Continuous studies in plant physiology and in the life-histories of insects could then be carried out both by the students and by the staff in their research work.

We also need additional equipment for individual work in plant physiology and microscopy.

Further, a reference collection of accurately named insects belonging to the Coleoptera, Diptera, and Hymenoptera is sorely needed. The Gibson collection of Lepidoptera purchased last year fills a long felt want in that we have now a ready means of identification of insects belonging to this order.

Report From Mr. T. D. Jarvis, Lecturer in Biology.

At my request Mr. Jarvis has furnished me with the following notes regarding his work during the past year:

Visit to the Cornell University. My holidays were spent at Cornell University, where I received instruction in systematic and economic ento-

mology from Prof. Comstock and Prof. Slingerland. I also studied parasitic fungi with Prof. Atkinson. While pursuing these studies I received many valuable hints and suggestions for future work.

Farmers' Excursions. You directed me in the month of June to erect a tent on the College campus, where farmers might go for information on Biological problems. Collections of weeds, wild plants, weed seeds, and some of our common insects were exhibited and methods of eradication of weeds and the extermination of insects discussed. The Perennial Sow-thistle, Field Bindweed, Ox-eye Daisy, Couch Grass and White Cockle, some of the worst weeds in Ontario, were much discussed by the farmers. They were interested also in San José Scale, Apple-Borers, Codling Moth, Cucumber Beetles, Canker-worms, Tent Caterpillars, etc.

Spraying to Kill Weeds. For many seasons past demonstrations have been given throughout Ontario for the destruction of Wild Mustard. It has been proven that, under favorable conditions, spraying with Copper Sulphate will destroy this noxious weed. Farmers are now beginning to ask if the same treatment will serve for Sow Thistle, Bindweed, and other weeds. In order to answer these questions, a series of experiments was made early in July on weed patches in the vicinity of the College. Twenty-eight species of weeds, representing twelve botanical families of plants, were sprayed with Copper Sulphate, and the following results were obtained.

The weeds were sprayed with the usual strength of solution, nine pounds of Blue Stone to forty-five gallons of water. The records of results are those observed six hours after the spray had been applied, but it should be stated that even twenty-four hours after spraying the effects were no wise different from those observed six hours after spraying.

Weed Spraying.

Name of weed.	Effect of spray six hours after Spraying.			Remarks
	Effect on stem.	Effect on leaf.	Effect on flower.	
Wild Mustard	Much injured	80 per cent. killed.	98 per cent. killed.	Practically all destroyed.
Wormseed Mustard	Not injured	Slightly injured	Slightly injured	Only slightly affected.
Shepherd's Purse	Slightly injured	50 per cent. killed.	10 per cent. killed.	Root leaves destroyed. Stem leaves only slightly affected.
Dandelion	" "	70 " "	5 " "	Leaves fairly sensitive, flowers only slightly affected.
Annual Sow-Thistle	" "	50 " "	5 " "	Leaves fairly sensitive, flowers only slightly.
Burdock	" "	40 " "	No bloom	Leaves fairly sensitive.
Ox-eye Daisy	Flower stems drooping	10 " "	10 per cent. killed.	Stems droop but revive again.
Chicory	Not injured	Not injured	10 " "	Only flowers affected.
Purple Fleabane	Slightly injured	15 per cent. killed.	20 " "	Only slightly affected.
Bull Thistle	25 per cent. killed	75 " "	No bloom	Leaves very sensitive.
Canada Thistle	Slightly injured	50 " "	" "	Not so sensitive as Bull Thistle.
Sping Sow-Thistle	" "	50 " "	Slightly injured	Leaves fairly sensitive, flowers only slightly.
Yarrow	Not injured	25 " "	Not injured	Leaves slightly sensitive.
Blue Weed	25 per cent. killed	75 " "	60 per cent. killed.	Leaves nearly as sensitive as Wild Mustard.
Stickweed	Slightly injured	50 " "	5 " "	Leaves fairly sensitive.
Hound's Tongue	Not injured	2 " "	2 " "	Only slightly affected.
Broad-leaved Plantain	"	Not injured	Not injured	Apparently uninjured.
Rib-Grass	"	5 per cent. killed.	"	Only slightly injured.
Motherwort	"	8 " "	"	" "
Catnip	"	Not injured	"	Apparently uninjured.
Black Medick	"	" "	"	" "
Field Bindweed	"	5 per cent. killed.	100 per cent. killed	Flowers very sensitive.
Purslane	"	Not injured	Not injured	Apparently uninjured.
Couch Grass	"	10 per cent. killed.	"	" "
Wild Buckwheat	Slightly injured	10 " "	"	Only slightly affected.
Curled Dock	" "	10 " "	20 per cent. killed.	" "
White Cockle	Not injured	25 " "	75 " "	Flowers fairly sensitive.
Round-leaf Mallow	"	Not injured	Not injured	Apparently uninjured.

Conclusions.

1. Wild Mustard is the only weed that can be readily destroyed by bluestone.

2. The flowers of Field Bindweed and White Cockle and the leaves of Blue Weed, Bull Thistle, Canada Thistle, and Sow Thistle are very sensitive to the spray, but further experiments will be necessary before this treatment can be recommended.

Outside Work in Biology. I have the honor of being President of the Wellington Field Naturalists' Club and Secretary of the Panton Club. The Wellington Field Naturalists' Club was organized about five years ago and the membership has increased very rapidly since that time. We meet fortnightly and many interesting meetings have been held during the past year. The migration habits and songs of birds, the time of flowering and habits of plants, and many insect problems have been discussed. The Panton Club is a scientific club formed at the College about three years ago. The members consist of students and officers of the College. Since the organization, many interesting scientific problems have been discussed. Among such are: "Mendel's Law of Plant Breeding," "The Life and Work of Charles Darwin and Thomas Huxley," "Evolution of Languages," "History of Childhood," "The Spectroscope," "Evolution of Plant and Animal Life," "Climatic Conditions of Ontario," etc.

III. Insects and Fungus Diseases.

Insects in 1904. As I have already stated, much of the correspondence of this department had reference to the depredations of insects and fungi. My report to the Entomological Society (see Report for 1904) on the "Injurious Insects of the Year" contains brief mention of the chief insects which were injurious to farm, orchard, and garden crops. Briefly, however, I may say that 1903 and 1904 have been "off-years" with insects, and the extent of their depredations have been below normal. Another noteworthy feature of these years has been the introduction of improved spraying machinery and better methods of spraying orchards. Power sprayers are now quite commonly used in the fruit regions, with the result that more thorough and more systematic work is being done. Also, better provision is now made for the preparation of the solutions and washes used in spraying.

Fungi and Fungus Diseases. Few persons perhaps fully realize the amount of damage done by parasitic fungi to the crops of the Province. When we consider the damage done to our wheat and oat crops by rust and smut, to the apple crop by apple scab, to the peach crop by the peach-leaf curl, to the potato crop by the late blight, and to the grape crop by the mildews and Black Rot, some idea at least is gained of the large losses every year, and we are strongly convinced that greater damage is done by fungus diseases than by insects.

On account of their peculiar habits, however, fungus diseases are not well understood by the ordinary layman, and sometimes methods of treatment are adopted which are not at all remedial in their action. Sometimes, too, the growers of plants wrongly assume that every plant which is diseased has been attacked by a parasitic fungus of some kind, and can be treated by sprays. On the other hand we know that diseased conditions are often set up in plants by unfavorable and unsuitable surroundings, such as soil, atmosphere, light, and temperature.

On account of the importance of the subject of Plant Diseases and the large number of inquiries for information received every year by this department, it was thought that a concise account of the habits of parasitic fungi in general, and a few *keys* for the identification of the diseases affecting apple, peach, brambles, groselles, and the grape, would at this stage be timely, and would also be appreciated by the readers of this Report.

What is a "Fungus"? A fungus is a plant, but it differs from the common green flowering plants in the following particulars: It lives on organic matter already prepared by its host; it has no green coloring matter (chlorophyll); it has no system of vessels; and it reproduces by spores and not by seeds. The body of a fungus consist of a *vegetative* or *nutritive* portion, always in close contact with its source of food supply, and a *reproductive* portion, dependent upon and attached to the vegetative portion. The vegetative portion is composed of a number of usually colorless, branching, thread-like tubes, which serve the same function as both root and stem of the higher plants. The presence of such fungal threads in any tissue disturbs the normal functions of that tissue, so that sooner or later a diseased condition is set up, followed either by the death of the cells or by abnormal swellings and distortions of the area affected. The fungus has grown rapidly at the expense of the food which should have been appropriated by the host plant. In some cases the fungus lives on the surface of its host, as in the case with the Powdery Mildews, and sends down into the cells within sucker-like branches by means of which it obtains the food necessary for rapid growth and development.

The reproductive bodies are *spores*, and are usually formed in large numbers. They are very minute, and can be readily carried in the currents of air for considerable distances. The spores are very variable in shape and size, but those belonging to any particular species are wonderfully alike. There are, speaking roughly, two kinds of spores,—the summer spores, produced during the summer, with thin walls, and capable of germinating under suitable conditions in a few days, and the winter spores produced in fall or in winter, thick-walled, and usually requiring a period of rest before germination. Frequently a fungus forms both summer and winter spores, and as these are usually quite unlike in appearance and in habit, botanists have frequently described different stages of the same fungus as two distinct species. Such mistakes have occurred with Apple Scab, Brown Rot, Bitter Rot, and several other forms.

Another peculiarity of some of these fungi with both summer and winter spores is that while they are passing through the summer stage they are serious parasites, i.e., they feed on living tissue, whereas they are *saprophytes* (feeding on decaying vegetable matter) during their winter spore stage.

A fungus gains an entrance to its host through the germination of the spores, and the growth of *germ-tubes*. As spores germinate only in the presence of moisture it is to be expected that moist weather with little sunshine is conducive to fungous infection and growth. Sometimes the germ tube enters the leaf through a breathing-pore or stomate; sometimes it secretes an enzyme which dissolves the cell-wall, and thus effects an entrance; and sometimes the spore alights on an open wound, or in a crack and thus finds an easy entrance. It is hard to explain why only certain fungi can infect and attack certain host plants, or in other words, why every plant has its own peculiar fungus.

Control of Fungi. From a study of the habits of parasitic fungi, we are able to indicate the best lines of treatment. These may all be included in the term *prevention*. A few of these preventive measures will be mentioned here: (1) The application of fungicides which either kill the spores

adhering to the plant or prevent them from germinating. To be effective the fungicide must be applied in a *thorough* manner and at the *proper* time. As a rule early spraying should be done to prevent germination of winter spores which are blown to the stems and leaves in early spring. Late sprayings must also be applied to kill the summer spores which have blown over from neglected plants, or have developed from winter spores which have germinated in spite of the treatment. The best general fungicide is Bordeaux Mixture, the preparation of which is well-known.

(2) *Pruning* is very effective in controlling such diseases as Black Knot, Apple Tree Canker, and Pear Blight, if all of the diseased wood is removed and burned.

(3) *Good, Clean Seed,* free from spores or disease is essential to the production of healthy plants. Smut in oats, wheat, and barley, and scab in potatoes can be prevented by attention to this point.

(4) *Cleanliness* about the garden, orchard, and farm in the matter of burning the fallen leaves and the destruction of diseased fruit is a very important factor in controlling disease, when we remember that many of the spores winter over in the fallen leaves and fruit.

Parasitic fungi injure their hosts by *appropriating* their food, thereby impairing their vigor, by *disorganizing* and *killing* tissues which contribute to the proper functioning of the plant or by *stimulating* the affected tissues to an abnormal growth called an *hypertrophy.*

Some Abnormal Growths and Their Causes. (1) *Corky Growths,* as in scab of potato, characterised by the development of large amounts of cork. Causes not clear, but may be fungi, bacteria, absence of lime, or dampness of soil.

(2) *Cankers,* characterized by open wounds in spite of attempts at healing. May be due to several causes: (a) *fungi* such as Nectria, Glomerella, and Sphaeropsis, (b) bacteria, (c) insects, such as Woolly Aphis, and Chermes.

(3) *Witches' Brooms,* characterized by irregular clusters of twigs at certain affected points. They are due to fungi, such as Exoascus and Aecidium.

(4) *Root Nodules,* irregular growths on root or at crown of root, may be due to one of several causes; (a) *Slime fungi,* as in Club Root of Cabbage, (b) true fungi, (c) bacteria, (d) insects, and (e) nematodes.

(5) *Erinoid Growths,* hair-like growths on leaves of poplar, oak, basswood, are due to the action of mites.

(6) *Galls* are enlargements due to the puncturing of young tissues by mites and insects, such as Phytoptus, Aphides, Cynipids, and Cecidomyiids.

Some Deformations and Dwarfing and Their Causes. (1) *Unequal Growth* on stems or leaves are due to fungi, aphids, or mites.

(2) *Dwarfing of a plant* may be due to lack of food materials, to insects or to fungi.

(3) *Leaf-Rolling* is due to insects or mites.

Wilting and Rotting and Their Causes. (1) Damping-off of Seedlings is due to a fungus (Pythium).

(2) *Rot* of fruits is due to various fungi, such as Monilia, Laestadia, Botrytis, Mucor, Penicillium, bacteria, etc.

(3) *Oedema* or *Dropsy* is due to excess of water.

Abnormal Coloration or Spotting and Its Causes. (1) *General Pallor* indicating a disturbance of the chlorophyll tissue, may be due to one or more of several causes: (a) Fungus attacks on roots, (b) insect attacks on

roots, (c) insufficient or too intense light, (d) too low or two high temperature, (e) too much or too little water in the soil, (f) lack of iron and other essential food materials in the soil.

(2) *White or Grey Spots* are due to Mildew, Septoria, &c., Cystopus, and red spider.

(3) *Yellow or Orange Spots* to rusts, aphids and red spiders.

(4) *Red Spots* to certain stages of Rusts.

(5) *Brown Spots* to blights, leaf spots, mildew and rusts, often a stage of disorganization of affected tissue.

(6) *Black Spots* to apple scab, pycnidial, and ascus stages of many sac-fungi, rusts, smuts, &c.

(7) *Brown Spots with Red Margins* to many anthracnoses and strawberry leaf-blight.

A Key to the Fungus Diseases of the Apple.

A. *The Roots*:—
   (a) Enlargements near the ground, mainly on nursery stock. Crown Gall (Dendrophagus globosus).

B. *Stems and Twigs*:—
   (a) Irregular or somewhat concentric open wounds, the bark being first destroyed. *Apple Tree Cankers* (Nectria ditissima), (Sphaeropsis malorum) and (Glomerella rufomaculans).
   (b) Bark becomes black or dark brown; the inner bark and cambium layer destroyed. Tree has appearance of being scorched. *Twig Blight* (Bacillus amylovorus).

C. *Leaves*:—
   (a) Small, roundish, smoky greenish spots appear on upper surface which soon run together, forming irregular, blackish blotches. *Apple Scab* (Fusicladium dendriticum) (Venturia inaequalis).
   (b) White patches appear on both surfaces of young leaves and run together, forming a white felt. *Powdery Mildew* (Podosphaera oxyacanthae).
   (c) Leaves become blistered with orange-yellow spots on upper surface and scurfy bunches on the lower. Leaves may become distorted. *Apple Rust* (Gymnosporangium macropus).

D. *Fruit*:—
   (a) Minute spots appear on half grown apple, gradually enlarging, and running together, forming irregular patches. Black points often in concentric circles form on the patches. *Ripe or Bitter Rot* (Gloeosporium fructigenum) (Glomerella ruformaculans).
   (b) Scabby patches appear on the fruit. *Apple Scab* (Fusicladium dendriticum) (Venturia inaequalis).
   (c) Sooty patches accompanied by specks appear on the fruit. *Sooty or Fly-speck Fungus* (Leptothyrium pomi).

A Key to the Fungus Diseases of the Peach.

A. *The Roots*:—
   (a) Soft corky enlargements usually at the crown of the Root, causing the death of the trees before they have attained full growth. *Crown Gall* (Dendrophagus globosus, Toumey).

B. *The Stem and Branches*:—
   (a) The buds unfold prematurely and the new shoots become slender, sickly, and yellow. *The Yellows.*

(b) The buds form compact tufts or rosettes, containing one or two hundred leaves, which are yellowish green. *The Rosette.*

(c) A copious outflow of gum upon the twigs and branches usually form spots near the buds. *Gummosis or Gum Flow.*

(d) New Shoots become thickened and enlarged. *Leaf-Curl* (Exoascus deformans).

C. *The Leaves*:—

(a) In May and June the leaves curl up, become deformed, much thickened and pale yellowish green, then rosy or purplish in color—affected trees lose their leaves before mid-summer. *Leaf-Curl* (Exoascus deformans).

(b) Numerous minute brown spots on the under surface of the leaves, which fall early. *Peach Rust* (Puccinia pruni-spinosae).

(c) Minute purplish spots appear; later the tissue dies, and minute holes like shot-holes appear in the leaf. *Shot-Hole Fungus* (Cylindrosporium padi).

(d) A white mildew appears on the leaves. *Rose Mildew* (Sphaerotheca pannosa).

(e) White mould-like growth, causing the leaves to become hard and curled. *Peach Mildew* (Podosphaera oxyaeanthae).

D. *The Fruit*:—

(a) Scattered tufts of a brownish mould first appear, followed by a soft rot. Later the fruit dries and may remain on tree over winter as a "mummy." *Brown Rot* (Monilia fructigena, Sclerotinia fructigena).

(b) Sooty-black spots or patches on the fruit, often accompanied with cracks. *Peach Scab* (Cladosporium carpophilum).

(c) Minute light brown velvety spots with a reddish border, frequently resembling minute pustules. *Brown or Pustular Spot* (Helminthosporium carpophilum).

(d) Large light-colored spots with formation of many surface hairs or fuzz. Under these spots the flesh becomes hard. *Rose Mildew* (Sphærotheea pannosa).

(e) Irregular, mouldy patches on the surface followed by a cracking of the fruit. *Peach Mildew* (Podosphæra oxyacanthæ).

A Key to the Fungus Diseases of Brambles.

A. *The Leaves*:—

(a) Orange-red patches on the under surface of the leaves, forming a sort of waxy layer of orange-red spores. *Orange Rust* (Cæoma nitens, Puccinia Peckiana).

(b) Light-colored, powder-like coarse dust or raised black dots on the under surface. *Leaf-Rusts* (Phragmidium rubi and P. Rubi-idæi).

(c) At first small reddish spots increasing in size and forming irregular areas, grey in centre and red on the margin. *Anthracnose* (Gloeosporium venetum).

(d) Small brown or light-colored spots. *Leaf Spots* (*Septoria rubi* and Cylindrosporium rubi).

B. *The Stem*:—

(a) At first small reddish spots on young canes, increasing in size forming irregular areas, grey in centre, red on the margin. *Anthracnose* (Gloeosporium venetum).

(b) The canes suddenly wilt about fruit ripening time, the bark and wood of cane at some points are discolored. *Cane-Blight* (Coniothyrium rubi).

(c) Stunted growth, mottled yellowish-green foliage and dry insipid fruit. *Yellows.*

(d) Rough, warty knots on canes, with small whitish eruptions surrounding the central knot, not common. *Cane Knot.*

C. *The Roots*:—

(a) Rough, knotty growth on the roots, granular and becoming dark when old. *Crown Gall* (Dendrophagus globosus).

A Key to the Fungus of the Groselles.

A. *Leaves*:—

(a) Cobweb-like patches first appear, later minute dark brown bodies on the leaves of Gooseberry—usually worst on English varieties. *Gooseberry Mildew* (Sphærotheca morsuvæ).

(b) Dull brown spots appear in June and July on the upper surface of the leaves which turn yellow and fall. *Anthracnose* (Glocosporium ribis).

(c) The leaves have a brown spotted appearance and fall prematurely. *Leaf-Spot* (Septoria ribis).

(d) The presence of yellow "cluster-cups" on the leaves, *Gooseberry Cluster-Cup* (Aecidium grossulariæ).

B. *Canes and Shoots*:—

(a) The tender tips of young shoots of Gooseberry covered with cobweb-like patches. *Gooseberry Mildew* (Sphærothacæ morsuvæ).

(b) Leaves of Currant wilt, color, and fall; fruit cluster shrivel and fall; the canes die rapidly. Pink tubercles of a fungus appear on dead canes. *Currant Tubercle* (Tubercularia vulgaris) Conidial stage of Nectria cinnabarina.

C. *Fruit*:—

(a) Cobweb-like patches occur on the fruit of gooseberry. *Mildew* (Sphaerotheca morsuvæ).

(b) Yellow blisters (Cluster-cups). *Gooseberry Cluster-cup* (Aecidium grossulariæ).

A Key to the Fungus Diseases of the Grape.

A. *Leaves*:—

(a) Pale green or yellowish spots on upper surface, and corresponding areas on lower surface covered with a delicate white mildew. The spots increase, become brown, and the leaf falls. *Downy Mildew* (Plasmopara viticola).

(b) White or greyish-white patches appear on the upper surface of the leaves, later they present a powdery appearance. *Powdery Mildew* (Uncinula spiralis).

(c) Small brownish patches appear on the leaves, on which are situated minute black points. *Black Rot* (Laestadia bidwellii).

(b) Small irregularly scattered, greyish spots bordered by a dark line: the central portion of the spots becoming dry, brown, and brittle. *Anthracnose* (Glœosporium ampelophagum).

B. *Buds and Shoots*:—

(a) Circular and irregular spots on the shoots. *Black Rot* (Læstadia bidwellii).

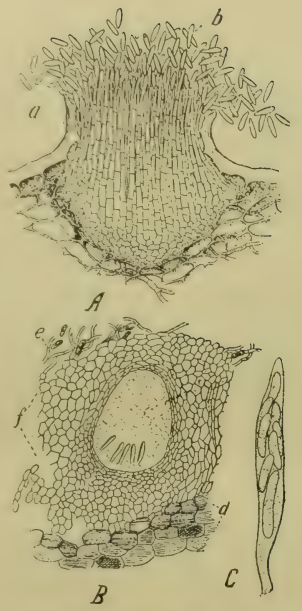


Fig. 2.—Microscopic structure of the bitter rot fungus. A, section through the affected part of an apple. The mycelium of the fungus has formed a mass of spore-bearing stalks (*conidiophores*) which have ruptured the epidermis of the fruit and formed a pustule from which numerous summer spores (*conidia*) are being given off; a, cuticle of apple; b, spores. B, section of an old affected apple showing the permanent winter stage of the fungus; d, cells of the apple on which is seated the thick walled spore case (*perithecium*); f, in which young spore sacs (*asci*) are forming; e, mycelial threads among which are scattered some two-celled spores (*conidia*): C, a mature spore sac (*ascus*) containing eight spores, (*ascospores*). All highly magnified. (D, E, after Burrill, the others after Longyear.)

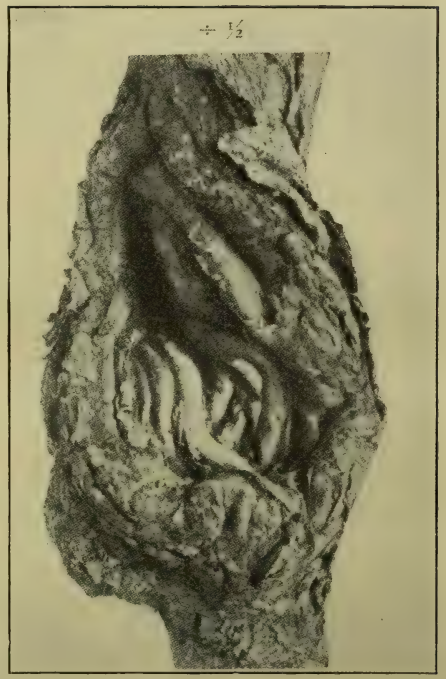


Fig. 1.—Nectria Canker.

Fig. 3.—Bitter Rot Canker (after Burrill.)

Fig. 4.—Two young trees showing cankers due to the black rot fungus, and produced by artificial innoculation by Paddock. a, pear ; b, apple.

Fig. 5.—Microscopic structure of the black rot fungus. A, section from a wintered specimen of crab apple showing, a, the darl colored mycelial threads among the cells of the fruit, b ; d, a thick walled spore case (*pycnidium*), which has pushed through the epidermis, c, and is giving off dark-colored spores, e, through the protruding mouth ; B, mature spores germinating in water and giving rise to germ tubes, f. All highly magnified. (After Longyear.)

C. *Fruit*:—

(a) Small brown or black spots appear on the berry, which soon become black, shrivelled, and hard, and studded with minute black points. *Black Rot* (Læstadia bidwellii).

(b) Irregular blotches occur, having a bright red ring inside the blackish border—sunken areas result. *Anthracnose* (Glœosporium ampelophagum).

(c) Irregular patches occur, pustules sometimes appear in concentric circles. *Bitter Rot* (Glœosporium fructigenum).

(d) A brown rot of the berries produced by a *downy mildew*. (Plasmopara viticola.)

D. *Root*:—

(a) Enlargements formed at or near the surface of the crown. *Crown Gall*.

Apple Tree Cankers.

In recent years considerable attention has been given to those appearances on apple trees commonly designated as *Cankers*, on account of the fact that but few orchards in the Province can be said to be free of them. Some of the best apple trees in many orchards have succumbed to the attacks of the canker, and the owners are already inquiring anxiously for information regarding the nature of this disease and the best methods of combatting it.

As a result of the observations and investigations carried on during the last few years it can be now definitely stated that there are several kinds of canker, each possessing its own peculiar characters, and each induced by a different cause.

Cankers are wounds kept open by the action of some agency in spite of the attempts of the tissuses to heal them. As a rule, they are conspicuous, whenever they are present, either by the absence of bark, or by the abnormal roughness of the bark clinging closely to the adjacent tissues, or by a large mass of dead and disorganized wood.

Cankers may be grouped and discussed according to the agencies causing them:—1. Sun-scald and Sun-burn Canker; 2. Frost Canker; 3. Nectria Canker; 4. Bitter-Rot Canker; 5. Black-Rot Canker; 6. Woolly-Aphis Canker.

Sun-Scald and Frost Canker.

Such a canker is nearly always observed on the south or south-west side of the tree. During warm days in winter the tissues on the sunny side of the trunk are warmed up and are incited to renewed activity. Such tissues always suffer from subsequent freezing, by the loss of water from the cells. Afterwards they contract and crack open. Similar effects are produced by the action of very dry, cold winds, which cause the tissues to lose much water.

The tissues destroyed in these ways become disorganized; the bark falls away from the wood, and saprophytic fungi effect an entrance before the wounds can be closed up by the rapid growth of the healthy tissue bordering on the wound.

Nectria Canker.

This canker, which is the common one in orchards in Europe, has been identified for a certainty in but few localities in Canada and the United

States. It is probable that it is in our Ontario orchards as it has been observed in the New York State and Nova Scotia. (Fig. 1.)

Massee describes this canker as being "a wound-parasite, its spores germinating in the first instance on some wounded surface, and from thence invading the healthy tissues. The bark is first attacked and destroyed, often cracking in a concentric manner; afterwards the wood is also destroyed, the canker often completely girdling small branches. As a rule a thickened, irregular, margin of living bark forms round the wound, giving a ragged appearance to the parts attacked, and very characteristic of the disease." Spores (conidia) are borne in autumn on minute, white cushions on the wound, and in spring ascospores are produced in small red perithecia, situated on the same cushions.

Bitter-Rot Canker.

This canker is very common in the orchards of Illinois and other central States. The relationship of this canker to the Bitter-Rot was discovered in 1902, when it was determined that the winter stage was passed on the cankers formed on the branches and often at the base of the old fruit-spurs. It was also proven that the main source of infection of the fruit was this winter and permanent stage of the disease in the canker.

This canker is most usually found on small branches, and starts from a bruise on the bark. "Growth takes place around the diseased area as it does about any wound, and there is formed an irregular encircling rim of healing tissue about a dead and depressed, or sunken, usually elongated, black patch, covered with dead bark." (Figs. 2 and 3.)

Black Rot Canker.

The Black Rot of apples is more or less common and well-known, but it is not so well-known that this same fungus produces cankers on the limbs of apple trees. The bark of affected areas first becomes discolored, then it becomes roughened and thickened. Sometimes the dead bark comes off, but usually the limb is girdled completely, and killed. Infection takes place in spring through wounds, and the affected "areas extend slowly as the fungus grows outward in all directions till midsummer, when a definite boundary forms between the dead and living bark." It is believed that sun-scald renders some varieties very susceptible to this canker. (Figs. 4 and 5.)

In all cases of canker the smaller limbs should be removed and the large ones scraped and painted to prevent re-infection. Diseased fruit containing the summer stages should be buried or burned. Winter applications of white-wash, and summer applications of Bordeaux Mixture will be of great service in controlling these serious enemies of the orchard. Steps should be taken also to protect the south-west sides of the trunks from sun-scald injury, and to prevent careless bruising or abrasion of the bark.

Realizing the importance of the Canker as a disease in our orchards, this Department will devote some time during the coming year to a further study of the different kinds of canker in order to determine the most effective method of controlling and preventing the ravages of the disease.

Respectfully submitted,

W. LOCHHEAD.

PART V.

THE PROFESSOR OF CHEMISTRY.

To the President of the Ontario Agricultural College:

SIR,—I beg to submit herewith my fourth Annual Report.

The work undertaken in this department naturally falls under three headings:—Teaching, Miscellaneous Work, including correspondence, addressing meetings, examining chemically a great variety of substances sent to the laboratory for that purpose, etc., and Investigation Work. As this is primarily a teaching institution, the instruction given to students in attendance in the regular college classes, and to those in the various short courses, is the most important part of our work, and naturally consumes the greater part of our time and energies. The work of answering letters of inquiry on practical points, examining miscellaneous substances, attending and addressing meetings of various kinds is important work and is increasing each year. We are also from year to year more frequently called upon to make chemical analysis to complete investigation work being done in other departments. The duties enumerated make it very difficult for us to undertake and successfully carry out any extended lines of investigation. There are three lines of work I am particularly anxious to see developed, namely: (1) investigation regarding the composition and digestibility of cattle foods; (2) development of the problems of Soil Chemistry and the most rational methods of Manuring for the many crops of the farm, and (3) the rendering of all possible aid in the solution of many difficult and intricate questions relating to the Dairy Industry. I am glad to be able to report that some work has been done along these lines. My Associate, Mr. Gamble, has already prepared and submitted for publication a bulletin on the composition of the various by-products from the flour, oat, pea, and starch mills of the Province. We have analysed some 35 samples of swamp soils, and I intend to continue the study of this class of soils by means of co-operative experiments during the coming season. Some work has also been accomplished in connection with the dairy industry. There are several other lines of investigation, as, for instance, problems in connection with the canning industry, chemical nature of insecticides and fungicides, wheat flour and baking, etc., etc., which we should take up more fully than we have in the past, but more assistance is required to do analyses before we can hope to make research a strong branch of our work.

I desire to thank you for allowing me some extra assistance during the year, and wish to acknowledge the hearty co-operation of all those associated with me in the work of this department.

TEACHING.

The nature of the work we are endeavoring to accomplish in the way of instruction to students is fairly well outlined in the College circular, and in my report of last year, and requires no extended notice here. In addition to the work of previous years, we have, however, had class work with the Junior and Senior Normal Classes in Domestic Science. The junior class take inorganic chemistry with our first year men, and the senior class are being given lectures and laboratory work in the chemistry of foods. The work in this subject consists of a brief study of the various

classes of oxygen derivations of hydrocarbons of the Marsh gas series in order that the relationship between the alcohols, aldehydes, acids, and etherial salts, and the properties of these classes of compounds, may be understood; a study of the food principle, as, for instance, the fats, carbohydrates, proteids, etc., and their functions when used as food, followed by a thorough discussion of the different groups of foods, fruits, condiments, etc., their characteristic composition and digestibility, common adulterations, etc., etc.

In addition to the instruction given to the regular college classes, lectures and laboratory work was given to the students taking short courses in Dairying, Poultry, and Stock Judging; to the instructors employed by the Western Dairymen's Association; and to a number of men who came in for special instruction throughout the year. Directing the work of men making chemical investigations in connection with these also absorbs considerable time.

Miscellaneous Work.

As the College and the work it is seeking to do become better known, letters asking for general and definite information along a great variety of lines, are received in increasing numbers. Many of these letters are accompanied by samples of various substances sent to us for analysis, identification, detection of adulterants, etc. I am desirous of making the work of the department as useful as possible to the farmers of the country and, therefore, anxious to comply with the request of all correspondents; but, unfortunately, time will not permit us to undertake all the work of this nature that is asked of us.

During the year I attended and delivered addresses at a number of conventions, among which were the Canadian Master Bakers' Association, Fruit Growers' Convention, and Butter Makers' convention. I also gave three lectures to the students of the Strathroy Dairy School, and attended the conference in Ottawa at which the Canadian Seed Growers' Association was formed.

A number of articles have been contributed to the press on various subjects relating to agriculture, and a special report as referee on "Vegetable Proteids" in connection with the work of the Official Agricultural Chemists' Association of America was prepared. Some special work was also done at the request of this Association, in co-operation with other chemists of the Continent, in testing methods for determining "quality" in wheat and flour, a report of which was made to the Association. At the request of the Executive Committee, I have consented to act as referee on the separation of "Milk and Cheese Proteids" for this coming year. This will entail a considerable amount of work, but we are in need of more definite information along these lines in order to carry on the investigation work we would like in connection with the Dairy Industry.

INVESTIGATION WORK.

Tests of Different Varieties of Sugar Beets.

For four years we have determined the percentage of sugar in all the varieties of sugar beets grown on the Experimental Plots at the College. Some of these varieties are of the large growing kinds commonly used for feeding cattle; other varieties are those grown for sugar factory purposes,

the seed being imported from some of the best known German seed dealers. The beets were grown on the level in rows 21 inches apart and thinned so as to leave the plants 8 inches apart in the row. The object of the experiment is to show the difference in the sugar content of the sugar factory varieties and those grown for feeding, and to compare some of the newer German varieties with the Kleinwanzlebener, the one now commonly used in this country.

PERCENTAGE OF SUGAR AND PURITY OF JUICE OF BEETS GROWN ON EXPERIMENTAL PLOTS.

Name.	Average weight of beets.		1904.		Average of four years.	
			Sugar.	Purity.	Sugar.	Purity.
	lb.	ozs.				
New Danish Improved	1	0.9	10.7	79.8	11.1	81.5
Red Top	1	8.5	9.6	82.7	10.7	83.2
Royal Giant	1	10.4	9.5	77.5	10.1	82.0
Giant Rose Feeding	1	8.4	8.8	74.5	13.4	84.7
Giant White Feeding	1	9.4	9.1	76.8	9.3	77.0
White Silesian	0	11.6	13.4	82.6	14.2	83.4
Red Skinned	1	2.4	11.4	85.0	12.7	83.6
White French,	0	13.2	14.0	83.0	12.3	82.9
Carter's Nursery	0	9.7	16.8	84.5	13.4	83.4
Green Top White	0	13.7	13.1	83.6	13.4	84.3
Lane's Improved	0	10.2	14.4	85.4	13.0	83.9
Champion	0	12.6	16.5	82.2	15.4	84.1
Queen of the Danes	0	14.7	12.0	79.6	11.7	82.0
Kleinwanzlebener	0	12.0	16.4	84.2	16.9	88.1
Jersey	0	11.3	11.7	86.9	12.9	86.6
Imperial Grey Top	0	12.0	16.7	86.7	15.6	86.7
French Yellow	0	10.2	12.7	82.1	13.0	83.6
Pitzscheker Elite	0	11.4	17.1	86.9	16.4	89.0
Improved Imperial	1	0.3	17.4	90.3	16.8	89.4
Vilmorin's French Sugar	0	8.4	15.5	86.7	15.6	86.7
					Average of three years	
Ideal	1	5.4	8.0	72.2	7.6	70.9
Mangel Sugar Beet	0	12.6	18.5	83.8	17.1	86.1
Tankard Cream	1	5.1	8.3	72.3	9.0	76.6
Jaensch's Victrix	0	9.9	17.5	89.0	17.0	88.6
Rubensamen (Rimpan)	0	14.2	17.9	89.2	17.6	89.5
Diechman, No. 1	0	14.4	17.0	85.6	16.8	86.2
Diechman, No. 2	0	12.1	17.3	83.5	17.1	87.5
Diechman, No. 3	0	8.9	16.4	81.5	16.7	86.4
					Average of two years.	
Rennie's Giant Sugar	1	0.3	11.4	81.0	11.1	80.1
Hybrid Sugar Beet						
Mangel	1	2.3	11.8	80.4	11.5	80.2
Imperial Giant Half Sugar	1	0.6	10.3	79.7	10.8	79.3

It will be noticed that the large growing, heavy yielding varieties, such as the New Danish, Ideal, Giant Half Sugar, Rennie's Giant Sugar, etc., are low in sugar and in the percentage of the solids made up of sugar. The average percentage of sugar in the Kleinwanzlebener is 16.9 with a purity of 88.1. Several other varieties have given equally good results. Rubensamen, as the results of three year's experimental work, gives the best average results, 17.6 per cent. of sugar and 89.5 per cent. purity. These results should be studied in connection with the yields which are given in Bulletin No. 140, prepared by the Experimentalist.

Test of Quality of Sugar Beets as Affected by the Distance between the Rows.

This experiment has been carried out for three years in succession. The beets have been grown by the Experimental Department in plots seven rows wide by four rods long, and on soil in uniform condition. The seed was sown on the level in rows 12, 14, 16, 18, 20, 22, 24, 26, 28, and 30 inches apart, and, in all cases, thinned so as to leave a plant every eight inches. The experiment was conducted in duplicate each year, and two sets of samples were selected from each plot. The object of the experiment was to determine what effect sowing beet seed in rows various distances apart has on the yield and quality of the beets.

Composition of the Juice of Sugar Beets Grown in Rows Different Distances Apart.

Space between rows in inches.	Average weight of tared beets.	1904. Analysis of Juice.			Average weight of tared beets.	Average Results of Three Years' Analysis.		
		Solids.	Sugar.	Purity.		Solids.	Sugar.	Purity.
	oz.				oz.			
12	9.5	19.5	17.3	88.7	9.6	18.9	16.7	87.9
14	9.8	19.3	17.5	90.9	10.6	18.7	16.6	88.6
16	9.6	19.9	17.6	88.2	11.8	19.1	16.7	88.8
18	10.0	20.3	17.7	87.0	11.6	19.0	16.7	87.9
20	11.3	19.9	17.8	89.3	12.4	18.9	16.9	89.2
22	13.3	19.4	17.8	91.7	14.3	18.6	16.5	88.8
24	11.8	19.9	17.9	89.2	14.8	18.8	16.5	87.8
26	12.9	19.5	17.5	89.8	14.9	18.7	16.4	87.4
28	15.9	19.4	16.8	86.6	15.4	18.5	16.3	86.5
30	16.8	19.7	17.4	88.9				

In every instance when beets were collected for analysis, samples were taken from all the plots the same day in order that uniformity of weather conditions might be preserved. Both this year's experiment and the average of the three years, shows there is a regular increase in the weight of the tared beets as the space between the rows is increased. There is, however, no corresponding falling off in quality. The percentage of sugar and purity do increase slightly up to where the rows are 20 inches apart and fall off somewhat from that point, especially in the purity column, but the decrease is not very great. Reference to the table giving yield of beets from the different plots which may be found in Prof. Zavitz's report, shows that there is a decided decreased yield as the space between the rows is increased. These results indicate that the best quality of beets will be got when they are grown in rows 18 or 20 inches apart, and that when the distance between the rows is increased there is a slight falling off in quality and a marked decrease in the yield. With the implements now at the disposal of the sugar beet grower, it is possible to conveniently cultivate between rows 18 or 20 inches apart. This is the spacing usually recommended by those interested in the production of beets for sugar factory purposes, and apparently the proper distance apart to give the best returns to the grower.

The Sugar Beet Industry.

During the past summer, the Dresden Sugar Co., removed their factory from Dresden to the State of Wisconsin, and the Wiarton Beet Sugar Manufacturing Co., suspended operations. As the Peterboro' people never completed their factory, there are only two factories manufacturing sugar from sugar beets in Ontario this season. Neither of these factories will receive sufficient beets to make a full campaign, but both companies express themselves as being satisfied with the prospect. Dr. Shuttleworth, of the Ontario Sugar Co., Berlin, writes on Dec. 15, 1904, as follows: "Our campaign, I think, can be considered as successful as might be expected for the third year. Farmers are apparently well satisfied. The pulp is in great demand, 4,000 team loads have been already hauled away and very nearly 200 carloads. The total tonnage will very nearly reach what we expected, and the sugar produced has been entirely satisfactory. The prices have been good, and almost the entire output ordered at regular prices as fast or faster than it was produced. We will, therefore, close our campaign with empty beet sheds, and entirely empty warehouse, and with a silo almost emptied of pulp. Better than all, the contracts for next year are coming in unsolicited much faster than last year."

In the month of July, I spent two days visiting the sugar beet fields in the Berlin district. They presented a decidedly improved appearance over that of the two previous years, and while some of the growers were not very enthusiastic over the prospects, the majority were proud of their sugar beet fields, and stated that they considered the crop one of the best, if not the best paying crop they had on their farm. Further, many of them did not hesitate to state that they did not consider sugar beets hard on the land, that it was a good cleaning crop, and that they thought it as good as a summer fallow for preparing the land for the other crops of the farm. The appearance of the crops on ground on which beets had been grown the previous year fully justified the statement. They also stated that, while there is a great deal of labor entailed in raising a good crop of sugar beets, it is not nearly so great as they had at first thought.

Wheat and Flour.

The opinion has been gradually gaining credence with the farmers in the Northwest Territories that the grain buyers were making too much difference in the prices paid for the different grades of wheat, that is, not enough was paid for the lower grades as compared with the higher grades. Early in the spring the Government of the Northwest Territories, through their Department of Agriculture, asked me to undertake work to show the real value of the various grades of wheat. After consulting you, I decided to undertake the work and wrote asking them to send me eight bushel lots of the various grades. I stipulated that each set of samples should consist of eight bushels, must be collected from one neighborhood, from one kind of soil, and that the wheat be graded by a competent man. This request was granted. All the wheat was grown on heavy loam or clay soils near Indian Head, and the grading was done by Mr. David Horn, Chief Grain Inspector, Winnipeg. The sacks were then labelled, and a seal placed on each. The wheat arrived in good condition with unbroken seals, and was immediately ground by Mr. E. J. Presant, miller, Guelph. Care was exercised to prevent the mixing of the various lots in the grinding process, and to insure the whole of the products being secured. The following table gives the weight of the wheat ground and of the products recovered:

It will be noticed that the total weight recovered is less than the weight of the wheat used. In explanation of this, I may say that the miller assured me that they lose in one way and another about two pounds on every bushel of wheat ground. The losses in this case correspond very closely with this estimate. The percentage of flour recovered is figured on the basis of the weight of wheat taken, not on the weight of cleaned wheat. Ten per cent. of low grade flour was removed from the portion saved for the baking tests and for analysis. The results of the analysis of the wheat and flour are given in the following tables:

TABLE I. SHOWING MILLING QUALITIES OF THE DIFFERENT GRADES OF WHEAT.

Lot.	Grade.	Total weight of wheat.	Total weight of flour.	Feed.	Total weight recovered.	Per cent. of flour.
		lbs.	lbs.	lbs.	lbs.	Per cent.
1	1 Hard.	476	337	125	462	70.8
2	1 "	473	330	127	457	69.8
3	1 Northern	556	389	148	537	70.0
4	1 "	481	334	126	460	69.9
5	1 "	509	360	132	492	70.7
6	2 "	473	323	134	457	68.3
7	3 "	480	328	136	464	68.3
8	3 "	477	325	136	461	68.1
9	3 "	488	333	131	464	68.2
10	No. 4	495	337	139	478	68.0
11	Feed	477	317	140	457	66.2

NOTE.—Lot 5 was what is known as "stook-frozen" or "riffled" wheat. Lot 9 was intended for No. 2 Northern and Lot 11 for No. 4, so as to have each grade in duplicate, but were placed a grade lower by Mr. Horn.

TABLE II. MOISTURE AND PROTEIDS IN THE DIFFERENT GRADES OF WHEAT.

Lot.	Grade.	Moisture.	Total proteids, N.X. 5.75.	Proteids soluble in 70 per cent. alcohol solution, N,X. 5.75-gliadin.	Per cent. of total proteids soluble in alcohol.
		Per cent.	Per cent.	Per cent.	Per cent.
1	1 H	11.74	11.89	4.87	40.95
2	1 H	11.93	11.81	5.06	42.84
3	1 N	10.75	12.205	5.24	42.91
4	1 N	11.31	11.65	5.043	43.29
5	1 N	11.79	11.195	4.525	40.40
6	2 N	12.11	11.985	4.94	41.20
7	3 N	11.02	11.625	4.92	42.30
8	3 N	11.05	10.745	4.525	42.09
9	3 N	11.16	11.85	4.90	41.35
10	No. 4	11.02	12.165	5.00	41.08
11	Feed	11.24	12.695	5.147	50.53

The object of the above analysis was to determine whether there was any marked difference in the amount of moisture present in the different grades of wheats, and to get figures showing the comparative amount of proteids, and the proportion of these soluble in alcohol. From the results shown in the above table, it is evident that there is no decided difference in this way between the various grades.

TABLE III. ANALYSIS OF THE FLOUR FROM DIFFERENT GRADES OF WHEAT.

Lot.	Grade.	Gluten.		Proteids.			Percentage of total proteids soluble.		Acidity.
		Wet.	Dry.	Total proteids, N.X. 5.75	Salt soluble, N.X. 5.75.	Alcohol soluble, N. X. 5.75 gliadin.	In salt.	In alcohol.	
		Per ct.	Per ct.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
1	1 H	33.16	13.29	10.91	2.39	5.77	21.85	52.8	.27
2	1 H	35.02	13.84	10.84	2.385	6.32	21.99	58.29	.27
3	1 N	32.14	12.66	11.13	2.385	5.37	21.40	48.24	.28
4	1 N	31.67	11.24	10.89	2.19	5.95	20.10	54.59	.28
5	1 N	31.66	12.13	10.13	2.23	5.725	22.01	56.51	.275
6	2 N	33.77	12.78	10.65	2.16	6.08	20.22	59.09	.275
7	3 N	30.45	12.15	10.65	2.35	6.20	22.06	58.22	.277
8	3 N	27.05	10.89	9.98	2.28	5.91	22.84	58.21	.284
9	3 N	31.18	12.08	10.09	0.92	6.025	8.97	58.75	.268
10	No. 4...	33.81	13.38	11.13	2.39	6.34	21.47	56.95	.28
11	Feed ..	29.48	11.39	10.33	2.30	5.625	22.26	54.46	.30

In explanation of the figures given in the above table, I may state that the value of a flour for bread-making purposes depends largely upon the amount and nature of the proteids it contains. The gluten proper forms part of the proteids; but, as determined by the washing process, there is always present in it some insoluble fat, fibre, etc., and thus almost invariably the percentage of dry gluten is higher than that of the total proteids. The true gluten is a mixture of two substances known as glutenin and gliadin. The latter is a viscous, sticky substance like glue; the former, a pulverulent material which gives body to the gluten. It is now generally considered that the quality of a gluten depends upon these two substances being present in proper proportions. A gluten very rich in glutenin is dry and short, does not rise easily and gives after baking a compact mass; a gluten too rich in gliadin behaves well during fermentation because it is soft and yielding, but, in baking the gliadin dissolves before coagulating, thus allowing the gaseous products to escape and the dough to spread itself and collapse.

The wheat grown throughout Manitoba and the Northwest Territories in 1902 was all low in gliadin, therefore as high a quality of bread could not be made from it as from that grown in 1903, which contained a much higher percentage of this substance. Reference to the figures in the preceding table indicates that there is no regular difference in the quantity of total proteids and gluten, or in the quality of the gluten between the higher and lower grades of wheat. In fact the percentage of total proteids soluble in alcohol (gliadin) is lowest in one of the samples of No. 1 Northern and the second lowest in one of the lots of No. 1 Hard.

The flours made from the various grades of wheats were baked three times, once on the 9th and 10th of June, almost immediately after the grinding was done, and a second and third time on the 20th and 21st of September. Nearly four pounds of each flour was used in the first baking test and about ten pounds in each of the second and third. The first baking was done by one experienced baker, using small ovens, while the last tests were made by two thoroughly competent bakers working together, and the bread was baked in a large oven in which all the loaves made from one full set of samples could be baked at once. The yields of bread obtained are given in Table IV.

TABLE IV. YIELD OF BREAD FROM 100 POUNDS OF FLOUR MADE FROM DIFFERENT GRADES OF WHEAT.

Lot.	Grade.	Weight of bread per 100 lbs. of flour.			Average of 2nd and 3rd bakings.	Quality of 2nd and 3rd bakings.
		1st baking.	2nd baking.	3rd baking.		
		lbs.	lbs.	lbs.	lbs.	
1	1 H	148.4	139.6	145.5	142.5	92.0
2	1 H	168.0	148.5	144.3	146.4	95.0
3	1 N	148.3	148.5	145.0	146.7	95.0
4	1 N	141.9	141.9	147.8	144.8	92.0
5	1 N	141.6	140.4	140.9	140.6	95.0
6	2 N	145.0	148.0	150.4	149.2	90.0
7	3 N	119.3	148.6	152.1	150.3	100.0
8	3 N	152.0	145.4	148.0	146.7	100.0
9	3 N	152.1	157.9	150.2	154.0	95.0
10	No. 4	151.6	155.5	151.1	153.3	80.0
11	Feed	146.7	150.1	153.3	151.2	80.0

Lots 2 and 7 gave quite different results in the first baking to what were secured in the second and third. Otherwise the yield of bread obtained from the various flours in the different bakings may be considered fairly close.

The quality of the bread is indicated by the figures given in the last column of the above table which were allotted by Miss Watson, Lady Principal of the Macdonald Institute, Guelph, and Miss Given, Instructor in Cooking, in the same institution. The best loaves were taken as a standard, and the others were graded from that. The bread made from Lots 10 and 11 was darker in color and of poorer texture than the others, but still good bread and of a nice appearance.

In order to further test some of these samples of wheats, I sent a small lot of wheats marked 1 H, 1 N, 2 N, and 3 N, to the Columbus Laboratories, Chicago. Their full report is as follows:

TABLE V. REPORT OF THE COLUMBUS LABORATORIES.

	Standard spring Patent.	One Hard.	One Northern.	Two Northern.	Three Northern.
Gluten	11.00	10.6	10.04	9.8	10.5
Ash	.42	.47	.48	.55	.53
Absorption	62.00	62.0	60.0	61.0	60.0
Colour	100.06	93.0	91.8	92.4	95.6
Loaves per barrel	100.00	100.0	98.8	99.4	98.8
Size of loaf	100.00	95.0	95.0	94.0	95.0
Quality of loaf	100.00	97.5	97.5	98.0	97.5
Average value	100.00	96.4	95.5	95.9	96.7
Fermenting period	100.00	100.0	99.2	94.2	99.6
Quality of gluten	100.00	98.1	99.6	101.0	98.5

NOTE.—In the above report the gluten and the ash are expressed as parts in each one hundred parts of the flour. The "absorption" is the amount of water necessary to add to one hundred parts of flour to make a dough of stand-

ard stiffness. The remaining values are so expressed as to show the relation to standard flour which for the purpose is given a value of 100 per cent. The loaves produced are made under carefully controlled and uniform conditions, and baked in accurately graduated baking cylinders in an electric oven. The value expressed as quality of loaf is expressed in per cent., is the mean value of colour, loaves per barrel, size of loaf and quality of loaf. It should not be taken alone in comparing the value of flours, but each of the factors of which it is made up should receive consideration.

Being straight grade flours the colors are low on these figures compared with that of the standard patent. In a patent flour, also, the quality of the loaf would equal that of our standard, as they are good in all particulars except color due to the straight flour. The gluten of these flours is small, and the loaf volume is correspondingly small. The quality of gluten is always somewhat better in the patent flours than in the straight grade from the same wheat. The absorption of the flours is fair for wheats of last year. The weight per bushel of these wheats was 1 Hard, 63 lbs.; 1 Northern, 60 lbs.; 2 Northern, 62 lbs.; and 3 Northern, 65 lbs. The amount of flour from each was 1 Hard, 75.6 per cent.; 1 Northern, 73.1 per cent.; 2 Northern, 73.7 per cent.; and 3 Northern, 73.7 per cent. These amounts are based on clean wheats.

Very truly yours,

THE COLUMBUS LABORATORIES.

Conclusions.

From the results of the work reported in the preceding tables, it would appear that there was not much difference in the real value of the different grades of wheat. It is also apparent that the sample marked "Feed" (Lot 11) was not by any means useless for bread-making purposes, either from standpoint of yield or quality of bread. For instance, if quality* in the bread be left out of the comparison and we value bread at 3 cents per pound and the feed and low grade flour at 1 cent per pound, 100 pounds of wheat of Lot 2 produces bread and feed worth $3.10, and 100 pounds from Lot 11, of "Feed" produces products worth $3.06, while the products of the same quantity of Lot 9 would be worth $3.17.

On the other hand it must be remembered that these results are obtained from a very few samples of wheat. The nature of the soil, the number of crops grown in it since "breaking," the weather at the time of ripening, etc., all have an influence on the quality of the wheat. Therefore, these results, while accurate for the samples submitted, should not be given too much importance until they are confirmed by further work.

PRESTON, STANLEY, AND PERCY WHEATS.

The Northwest Territorial Government also sent samples of varieties of wheat known as the Preston, Stanley, and Percy to us for analysis. These are comparatively new varieties and have been grown in the Northwest for only a few years. Considerable discussion has arisen as to whether they are

*The bread from lots 10 and 11 were dark enough in color to seriously discredit them for bakers' use, as public put great stress on color of bread.

equal in quality with the old Red Fife so well-known throughout that country. The results of the analyses are as follows:

ANALYSIS OF PRESTON, STANLEY, AND PERCY WHEATS.

Wheat.	Moisture.	Total Proteids.	Proteids soluble in alcohol, gliadin.	Per cent. of total proteids soluble in alcohol.
	%	%	%	%
Preston	10.45	11.97	5.22	43.60
"	11.86	11.11	4.81	43.65
"	11.36	12·14	5.46	44.97
Stanley	10.74	12.76	5.54	43.41
"	10.86	11.36	4.70	41.37
Percy	11.13	12.8	5.37	44.45

These wheats contain a fairly high percentage of proteids, fully as high as the samples of the various grades previously mentioned. They also contain as much alcohol soluble proteids, or gliadin, as the wheats referred to, and, so far as can be judged from these results, ought to be equal to them for flour purposes.

QUALITY OF FLOUR FROM WHEAT GROWN IN MANITOBA AND NORTHWEST TERRITORIES IN 1904.

The flour made from wheat grown in the North West in 1902 was not of good quality. The bakers complained that it was weak, and would not stand the proper amount of fermentation. This year similar complaints are being made, and several samples of flour have been sent to us for analysis. One baker states that "We have used less heat in setting sponges now than we did in the summer. The dough works soft, and the bread is inclined to be sad. . . . We use a dough mixer, and dough does not toughen up but the blades of the mixer cut through it." Examination of the flour two years ago revealed the fact that it was low in gliadin, the constituent of gluten which gives tenacity to the dough. Last year the percentage of gliadin was higher, and the flour was of better quality. This year the proportion of gliadin is again low, and it would appear as though this is the cause of the trouble complained of.

The following table gives the average results of the analysis of a number of flours made during the last four years:

PER CENT. OF TOTAL PROTEIDS AND GLIADIN IN FLOUR.

Number of samples analysed.	Grade of flour.	Year wheat was grown.	Total proteids.	Gliadin.	Per cent. of proteids in form of gliadin.
4	Patent.....	1901	11.65	7.64	65.5
4	Patent.....	1902	12.83	6.20	48.3
11	Straight ...	1903	10.61	5.94	55.9
13	Patent.....	1904	10.34	5.22	50.5

Investigations have not yet made plain just what proportion of total proteids of a good flour should be in the form of gliadin. The Patent grades of flour always contain a larger proportion of proteids in the form of gliadin than the lower grades, and, consequently, are stronger flours. All the differ-

ent samples of flour analysed were of Patent grade, excepting those of the year 1903, when they were all "straight" grades, only 10 per cent of low grade having been removed. This will account for the somewhat low gliadin figure for that year. It is evident, then, that the flour made from wheat grown in 1904, —like that of 1902, is low in gliadin. In one case two samples of "Patent" flour, both from new wheat, were submitted for examination. One was marked "No serious trouble with", the other, "very much trouble with". On analysis it was found that the former contained 54.4 per cent. and the latter 50.3 per cent of proteids in the form of gliadin. As no other difference in these flours was found, it would appear that this was the cause of the trouble. This would indicate that the wheat from some sections is better than others, but we have no data at hand to warrant the drawing of definite conclusions on this point.

The effect of low gliadin content would be that the gluten would be weak, the acids developed during fermentation would more quickly dissolve or "rot" the tenacious part of the gluten and allow the gases to escape. As a result the bread would be heavy. Just what causes this low gliadin content in the wheat is no known. It apparently is not caused by the soil, for these variations in strength come from year to year in wheat grown on the same soils. It is more likely due to weather conditions at the time the nitrogenous substances are being transferred from stem to seed, or during the ripening process. The only remedy we can offer at present is to grind as much as possible of the wheat of 1904 with that grown in 1903, or mix it with some of the softer winter wheats which naturally contain large proportions of gliadin.

Acidity of Flour.

During the last year we have determined the acidity of a large number of flours. The better grades of flour show a very small acid content, but the amount increases with the lower grades. Flours which have taken up an undue amount of moisture or, which have been made from damp wheat, also show high acid content. The object of our work in this connection is to determine, if possible, the limits of acid which will occur in flour of the various grades, but, more particularly to secure figures showing the limits of acid in sound flour, and then, by using an alkaline solution to measure the acidity, give the millers and bakers a simple and efficient method or determining the soundness of flour. Such a method is very much needed, but before it can be used intelligently we must examine enough good and bad flours to determine the proper limits of acid.

Swamp Soils.

Scattered here and there throughout almost every township in the older part of Ontario there are many swamps varying in size from a few acres to hundreds of acres, and amounting in the aggregate for the whole Province to many hundreds of thousands of acres, which have been drained and brought under cultivation. These soils are usually very black and very rich in organic matter, and they are frequently drained at great expense with the expectation that they will be very productive and almost inexhaustible, but not infrequently the results have been disappointing.

In response to an evidently growing demand for further information regarding the best methods of treating this class of land, we have decided to study their deficiencies, and hope before long to be able to report some definite method of treatment that will give more uniformly good results than are at present obtained.

Last spring, we sent out nearly one thousand circular letters to farmers in different parts of the Province who owned and were cultivating swamp land,

asking for certain general information. A very large percentage of these circulars were returned with the questions fully answered. From the information gathered, it is evident, as might be expected, that there is a great difference in the depth and state of decomposition of the black materials, and in the nature of the underlying substances. In some cases the black top soil is but a few inches deep and well decomposed; in others, it is many feet deep and contains much coarse, partially decayed, woody matter, which when drained is incapable of holding enough moisture to produce a crop of roots or grain. In most instances, the organic matter of these swamp soils consists largely of partially decayed sphagnum moss. Later in the life of the swamp, and particularly where the accumulations of organic matter has not been large, trees, such as cedar, tamarac, elm, ash, etc., have added their quota of decaying matter to that already present. The water which gathers in these swamps is usually surface-drainage or seepage water, and contains sufficient of the essential elements of plant food to supply the needs of the plant life in it; but, as the accumulated organic matter decays, the ash constituents, potash, phosphoric acid and lime, revert to soluble forms and are carried away in the drainage waters flowing from these swamps, or down into the subsoil. If the subsoil is clay, it may gradually become very rich in these ash constituents; if it is sandy, most of them will be lost, as the sand has not the same power of holding these fertilizing substances. Naturally, then, these swamp soils will be rich in nitrogen and comparatively poor in the ash constituents.

Many of the farmers to whom circulars were sent, state that they have been getting excellent results from this class of soils, while others state that when grain was grown, a great deal of straw was produced, almost always lodging badly and the grain filling poorly. This would be the natural result where the land is rich in nitrogen and poor in the ash constituents. Many farmers have found that where the clay subsoil can be mixed with the top black muck good results are secured. The reason for this is apparent. But where the top soil is too deep to allow of this, or where the subsoil is sandy, this method of treatment cannot be followed. In some cases the reports show good results following the burning off of some of the top soil. Where there is a great depth of black muck, this method may be followed and the remaining soil improved because the ash produced brings up the balance between the various essential constituents for plant growth; but the danger is that the fire will run too deep and destroy all of the organic matter and leave the soil poor in nitrogen, the constituent which is naturally so abundant. At best, the method is wasteful, and should not be followed except in extreme cases and at times when the fire can be controlled.

With the object of gathering some definite knowledge of the composition of these swamp soils, we have collected and analysed 35 samples of various types. In every instance we have a record of the previous cultivation and the nature of growth on these soils. None of the soils could be said to be "sour" or acid, although a few were rather low in lime. They, however, all contained a low percentage of both potash and phosphoric acid, much lower than the ordinary arable lands, and they were all exceptionally low in "available" ash constituents. Some good authorities state that soils to be productive should contain as much as .03 per cent. of potash and phosphoric acid in a form available for plants. Only a few of them reached this minimum limit, and many of them contained as small an amount as .005 per cent.

It is our intention to follow up the study of these soils with co-operative experiments with fertilizers next season, and some of the owners of the soils from which the samples analyzed were taken have signified their willingness to carry out these experiments.

Abitibi Soils.

During the last excursion of the Provincial Bureau of Mines Exploration Party into the Abitibi District, Mr. A Henderson, Biologist of the party, collected a number of samples of soils typical of the sections passed through. As we could not undertake to analyse all the soils collected, Mr. Henderson selected seven samples, each of which had been gathered in such a way as to fairly well represent the soil characteristic of as many different sections of the country and submitted these for analysis.

The following notes on the location and the trees growing on the soil from which the samples were taken were made by Mr. Henderson:—

No. 5. From Frederick House River bank at the north boundary of Mann township. Timber—spruce, six to eight inches, birch 5 to 6 inches, and poplar 10 inches in diameter, growing about 40 feet high.

No. 8. From north boundary of 3rd township north of Tulley. Surface of ground cut by many ravines 20 to 40 feet deep, with clay bottoms and a somewhat thin layer of sandy soil on the elevations. Sample taken from elevations between the ravines. Heavily timbered, principally birch, spruce, and poplar, 16 to 20 inches in diameter.

No. 9. From Teefy township. Characteristic soil of the Abitibi River bank, extending from one-quarter to two miles back from river. Heavily timbered, poplar, spruce, balsam, and occasional birch and Jack pine, trees large. There is a well decayed covering of humus six inches deep.

No. 11. From Knox township, Jack pine soil. Principal trees Jack pine, poplar, black spruce, and a few birch, rather small. Very little decaying organic matter on surface.

No. 17. From Teefy township, at Iroquois Falls. The most common soil in the Abitibi District,—the representative soil,—along with No. 9 of the great "clay belt." Timber is poplar, spruce, and balsam,—poplar grow very large.

No. 23. From bank of creek flowing into Frederick House River near the point where it crosses Niven's line (mile 157). Timbered with spruce, poplar, balsam, 8 to 15 inches in diameter. Scattered timber, much wind fall. Cedar 12 inches in diameter along water edge.

No. 30. From bank of creek in Knox township. A common soil along creeks and rivers. Luxuriant growth of river hay, willows, alders, etc. Apparently the most productive soil in the Abitibi district.

The following table gives the composition of the soils. The samples were taken below the layer of decaying organic matter, and may, therefore, be considered subsoils.

Composition of Soils from Abitibi District.

Constituent.	No. 5	No. 8	No. 9	No. 11	No. 17	No. 23	No. 30
Moisture	1.4	0.22	3.4	0.72	4.30	3.91	5.29
Organic and Volatile	3.9	1.39	13.55	3.64	14.33	7.36	18.24
Insoluble Residue	86.3	96.0	67.3	68.7	64.8	68.1	54.8
Iron and Aluminium Fe_2O_3 and Al_2O_3	6.52	1.04	9.23	4.3	12.15	14.45	11.814
Lime CaO	0.795	0.46	1.615	0.91	1.285	1.08	1.81
Magnesia (MgO)	0.51	.....	0.482	0.767	1.34	2.26	0.60
Potash (K_2O)	0 25	0.095	0.75	0.118	0.74	0.864	0.96
Phosphoric acid (P_2O_5)	0.115	.....	0.17	.....	0.143	0.105	0.238
Total Nitrogen	0.087	0.047	0.387	0.07	0.297	0.12	0.512
Humus	1.28	0.45	6.98	0.90	5.05	1.07	6.42

The above table of analysis does not give definite information regarding the form of combination of the various plant food constituents, nor does it tell how much of the potash and phosphoric acid are in an available form; but it does show plainly which soils have enough plant food to rank as good productive soils, provided the physical conditions are right. Soil No. 8 is low in every one of the valuable plant food constituents, and is utterly unfit for agricultural purposes. No. 11 is very little better and No. 5 is hardly up to the minimum limits for good crop production. Fortunately these soils form a comparatively small part of the Abitibi district and should never be cleared up, but should be kept as forest reserves. According to the figures in the table, soil No. 30 should, other conditions being equal, give the best results when it is put under cultivation. This agrees with Mr. Henderson's notes, for he pronounces this the most productive soil in the whole Abitibi district. The most important point in connection with these analyses is, however, the fact that soils Nos. 9 and 17, which Mr. Henderson states are the representative soils of the "clav belt," are well supplied with lime, potash, phosphoric acid, and nitrogen. They are a little low in phosphoric acid, but it must be remembered these samples were taken below the top black mould and are, therefore, more likely to be poor in this constituent. It it very doubtful if any of the ordinary soils of older Ontario ever contained a larger amount of the mineral constituents required for plant growth than these Abitibi soils.

INSECTICIDES AND FUNGICIDES.

Lime Sulphur Washes.

Last spring at the request of a number of the fruit growers of the St. Catharines district, I went to St. Catharines and prepared a number of barrels of the lime, sulphur, and sal soda wash according to the formula proposed by Dr. E. P. Felt, State Entomologist, New York State, which is as follows:—

Lime	25 lbs.
Sulphur (flowers)	20 "
Sal soda	12½ "

I also prepared a number of barrels of the lime-sulphur-caustic soda wash. This wash, I believe, was first used by the Geneva Experiment Station, New York State. The formula is as follows:—

Lime	30 lbs.
Sulphur (flowers)	15 "
Caustic Soda	4 to 6 "

In preparing these mixtures, we first placed 5 or 6 gallons of hot water and the sulphur in a barrel and thoroughly mixed the two together. The lime was then added and the whole mass stirred to prevent caking on the bottom of the barrel. If the lime is fresh and of a quick slaking kind, it may be necessary to add a little cold water to prevent the mixture boiling over. When the violent boiling ceases, add the caustic soda or sal soda, whichever may be used, and stir to mix it with the contents of the barrel. Cover the barrel with any material that will help retain the heat and let stand for 20 minutes to half an hour, when it is ready for use. The washes thus prepared developed the deep orange red color of the well boiled mixtures, and, from the observations made by competent men, appeared to give almost, if not altogether, as good results as the lime-sulphur

wash prepared by boiling. A full report of these experiments will be found in the Fruit Growers' Report for 1903. I would like to strongly emphasize the fact that the greatest care must be exercised in the preparation of these washes. Only fresh burned lime of quick slaking kind should be used, and even then it is better to select the larger stones; in fact every care should be taken to recover the maximum amount of heat from the slaking. The caustic soda should not be used in the lump form, but must be in a granulated or powdered condition, so as to allow of its going into solution quickly.

The washes are no better and possibly not so efficient as that prepared by boiling, but the ease with which they may be prepared will greatly recommend them to the fruit grower who has not enough trees to warrant him installing a steam boiling plant.

Fungeroid.

Some of this fungicide was used in the Niagara district on grape vines affected with the grape rot. For this purpose it was applied after the grapes were nearly full grown by means of a specially prepared machine. It is a light grey, practically anhydrous powder. The samples analysed had stood for sometime exposed to air, and had doubtless absorbed some moisture. As the composition of this fungicide will be of interest to a large number of fruit growers, the results of the analysis are given below:—

Cupric oxide (CuO)	13.52 per cent.
Sulphuric anhydrous (SO_3)	14.42 "
Lime (CaO)	41.04 "
Sodium oxide, carbon dioxide and water	31.02 "

It evidently contains much more lime than there would be in the solids of the soda Bordeaux prepared according to the usual formula, but a little less than in lime Bordeaux of the old 4.4 and 4.0 formula.

Preservatives in Butter.

It is a well-known fact that it is only by exercising the utmost care through every step in the production of the milk, handling of the cream, and manufacture of the butter that the delicate, fresh, sweet flavor so much desired in good butter can be secured. It is also well-known that even the most carefully prepared butter deteriorates after its manufacture, and that it requires intelligent, skilful handling to retain its fresh aroma long enough to reach the British market, which is our best, and, at the same time, most critical customer.

Butter-making is essentially the separation of the fat as completely as possible from the milk and cream and recovering it in a compact mass, consisting almost of fat and water. The fat consists of a number of compounds composed of acids in union with glycerine, and belongs to the same class of compounds as many of the flavoring substances in fruits, flowers, etc., some of which have the most delicate odors; but which upon decomposition yield volatile products of a decidedly offensive nature. Furthermore, some of the fats are unsaturated compounds, which, doubtlessly, more or less readily combine with the oxygen of the atmosphere and thus set in motion changes which may not only destroy the pleasant flavoring substances, but also produce the disagreeable rancid smell common to bad butter.

In addition to fat and water, butter also contains a small amount of nitrogenous and mineral matters. The amount of the former substance in good creamery butter is not large, and, while it readily undergoes putrifaction changes, does not appear to directly affect the keeping quality of the butter. It, however, serves as a food for the micro-organisms present, which causes the changes and thus serves indirectly to produce bad flavors.

It will thus be seen that the constituents of butter in their natural state are all delicate substances, some of which, or a combination of the whole, produce the peculiar aroma of good butter, and that some of the fats, especially the glycerides of the volatile unsaturated acids, may be easily decomposed.

All the faults of butter may, in a general way, be grouped into two classes: First, those faults which appear immediately after it is made; and second, those which are acquired from standing, caused either by the absorption of different taints from unfavorable environment, or by the development of undesirable germs already present in the butter. The faults which fall into the first group are those which originate from the food, infection of milk, or cream with undesirable ferments, and improper methods of manufacture. Through special efforts in the feeding of cows, and skill in the care and treatment of milk and cream, these faults can be overcome. They are within the control of man.

Those faults which come under the second heading are, as a rule, natural to butter in a greater or less degree. All butter will go "off" flavor on standing, no matter what methods of procedure are adopted in its manufacture. We cannot wholly eliminate the cause of deterioration, but we can retard or delay the action of the enzymes, or whatever it may be that cause the splitting up of the fats and the production of the rancid flavor, and thus make it possible to keep butter longer.

There appears to be three ways by which this may be done, namely, (1) by pasteurizing; (2) keeping the butter in cold storage, and (3) by the use of preservatives, or better, by the combination of all three methods of treatment. Salt is the preserving material which we have depended upon almost entirely in the past, but the English market now demands large quantities of practically saltless butter. If then salt cannot be used, it would appear all the more necessary that something else be added to the butter to prevent or retard the action of the micro-organisms through whose agencies the various changes are brought about which produce what are called "off" flavors.

The Dairy department has conducted a large number of experiments to study the effect of preservatives on the keeping quality of butter, and we have analysed samples of nearly all the different brands in use in the Province and gathered other useful information regarding their use. It is our intention to prepare almost immediately a joint bulletin, in which the details of this work will be given, and, therefore, I will not take up these results in this report.

Need of Increased Accommodation.

I desire again to call your attention to the fact that the laboratories in the Chemical building are altogether too small for the purposes for which they are required. We are endeavoring to give laboratory work to all of our classes in chemistry, and for this purpose have the table space originally planned for 32 men. When it is pointed out that we have 100

students in the First Year, 60 in the Second Year, 26 in the Third, and 30 in the Fourth, and that the senior years are given the regular courses in qualitative and quantitive analyses, and also go through the analysis of soils and fodders, it will be seen how inadequate the accommodation is. In addition to the classes mentioned, we have, this past term, had 25 young ladies from the Domestic Science Department taking inorganic chemistry, and as many more studying the Chemistry of Foods. We have tried to make the best possible use of the space, but the students have been too much crowded to do thoughtful work. As the needed laboratory space can be added without tearing down any part of, or in any way injuring the present building and at comparatively little expense, I sincerely hope that some addition may be made to the building before another College year opens.

Respectfully submitted,

R. HARCOURT.

December 30th, 1904.

PART VI.

THE LECTURER IN CHEMISTRY.

To the President of the Ontario Agricultural College:

SIR,—I beg to submit herewith a brief report of my work for the year ending December 31st, 1904.

TEACHING.

During six months of the year my attention has been entirely concentrated on teaching. The ground covered was practically the same as that outlined in previous reports. It is, therefore, unnecessary to take up valuable space with a review of this work. I would like, however, to emphasize the importance of the lectures and laboratory work. As is well known, many of our young men come to the College with but a very elementary public school training. To such students the subject of Chemistry at first appears to be incomprehensible. Gradually, however, as the fundamental laws underlying the science are unfolded, the close relationship between it and practical agriculture is realized, and the student appreciates very greatly the value of even an elementary knowledge of the subject.

In teaching this subject, I have always found myself handicapped by insufficient equipment in the way of apparatus. It is necessary for the student to have a course of laboratory work to supplement the lectures. We hope, therefore, that a more liberal grant may be forthcoming, in order that this important branch of a scientific agricultural education may attain the highest degree of perfection.

The work of the dairy class is an important part of the teaching. In this, as in all our instruction, the practical side is emphasized. It is perhaps, impossible to point to any specific number of cases where the good that

a training in elementary chemistry for dairymen can be accurately measured. Yet, we are confident from the keen interest exhibited by the members of our dairy classes that the instruction given has not been lacking in good results.

The conduct of the student body in the class room has been excellent, and I am proud to say that the eager interest of our students in their studies has been a great source of satisfaction as well as a great incentive to me.

Work Completed.

A bulletin, which is now in the hands of the printers, contains figures representing some 250 analyses of by-products from the mills of Ontario. This work will be continued for some time in order to ascertain the average composition of by-products, such as oat bran, shorts, pea hulls, etc.

Information Regarding the Condition of our Export Trade with Great Britain.

Anyone who has followed the development of export trade must realize that we have an invaluable market in the mother country. But many fail to appreciate the fact that in order to establish a sound business with Great Britain we must supply her merchants with goods of the very best quality. The average English consumer does not consider the cost of household commodities so long as his taste is gratified; but he strongly objects to paying even a very low price for an inferior article. The price paid for Canadian cheese and butter illustrates this fact very well. In the case of cheese, there is a large and growing demand for this article in England; whereas, at the present time, there appears to be a very strong prejudice against Canadian butter. It is gratifying to know, on account of the large manufacture of cheese in Canada, that our output receives such satisfactory mention by leading merchants in London, Manchester, and other large centres. At the same time, it should be a matter of sincere regret to all true citizens of Canada that our export butter does not reach to the same degree of excellence. Every effort should, therefore, be put forward to place our butter on the market in a condition such that it will command the highest price. The difference in cost of manufacture and proper handling of this perishable product of the farm would be practically nil as compared with the enhanced price which it is possible to obtain.

What has been said of our cheese and butter applies in a general way to our canned goods trade. It was with the object of obtaining some reliable information along this line that the writer, during the past summer, visited a number of the leading wholesale houses in the Old Country.

Canned Peaches, Pears, and Apricots. A number of the wholesale houses did not handle Canadian canned goods at all. In other houses where our canned goods are to be found the general complaint was that our peaches, pears, and apricots are pulpy in appearance. When our cans were opened and compared with those sent from the United States the difference was very marked. The fruit from the other side of the line retained its perfect form, and was certainly more attractive than ours, half of which was in pulp and had more of the appearance of boiled turnips than of fruit.

The general impression among the merchants appeared to be that our manufacturers purchased the fruit after it had become too ripe, or else that a very inferior variety of fruit, such as windfalls, etc., was used. Notwithstanding this fact, the flavor of our canned peaches was excellent, in fact much

superior to that of the California fruit. The general concensus of opinion appeared to be, however, that Canadian manufacturers must look more closely after the raw material if we are to have a leading place in this very important industry.

Canned Raspberries. The writer was shown a very fine display of canned raspberries. The fruit was put up in glass sealers, which were neatly labelled. This particular kind of fruit presented a very attractive appearance, and sold readily at good prices. In speaking of this fruit, Mr. Robinson, of the firm of Hanson, Son, & Barter, said: "We cannot get enough of your canned raspberries to supply the demand. We have had to cancel a large number of orders for this brand this season. Our customers say the fruit is excellent. If more of your fruit could be put in glass the prices paid would certainly be much higher than they are at present."

Canned Tomatoes and Corn. There is a steadily growing demand for tomatoes and corn in England. Some few years ago there was a decided prejudice against canned goods of any kind, the reason being that a few cases of poisoning supposedly resulted from eating such foods. This prejudice appears to be gradually dying out. But there is a complaint at the present time that our manufacturers are not sustaining their record in the matter of quality. One defect pointed out to me was a blackening of the corn at the top of the can. This was probably caused by the soldering iron scorching the corn during the process of sealing the cans. In contrast with the black surface exposed when a can of Canadian corn was opened, several merchants showed me how the American manufacturers overcome this difficulty. They place a clean piece of parchment paper over the corn, and in this way are able to obviate any blackening of the canned goods. One dealer told me that he did not so much object to a little of the corn being blackened, but it gave the customers a bad impression of the goods to see this black surface when the can was opened. The customers often mistake this blackening of corn for foreign matter, and very strongly object to it. A little care in sealing the cans, and a small piece of parchment paper placed underneath the lid prevents any such false impression.

Canned Peas. There is a very limited demand for Canadian canned peas on the English market, mainly, for the reason that most of our peas are white. The most of the peas sold in England come from France, and are colored by the use of a dilute solution of copper sulphate. I may further add that the canned pea trade in Great Britain at the present time is in a very unsatisfactory state, because of a law prohibiting the use of copper sulphate in any process of manufacture. The merchants say that it is absolutely impossible for them to sell canned peas unless they are colored, and it is practically impossible for them to obtain sufficient peas to supply the demand of their customers unless they are permitted to sell peas which have been colored by copper sulphate solution. Several merchants have been fined for selling such goods, and a number of cases are now before the courts pending the decision as to whether or not a small percentage of copper sulphate may be used in the process of manufacture of this particular article of food.

Canned Beef and Tongue. Some of our Canadian manufacturers have the reputation, in this particular line, of putting up a first-class article. In other cases the complaint is made that our canned tongue cannot compare with that placed on the market by Chicago firms. The main points of excellence in the American canned tongue appear to be: first, the neat attractive labels on the cans, second, a more attractive appearance of the tongue when the can is opened, and third, not so much of the throat of the animal is left at-

tached to the tongue. From the English buyer's standpoint the tongue should be freed from all appearance of the throat or gristle. The writer was shown several of these cans opened, and in some cases the complaint is quite justifiable.

In conclusion let me say that I believe there is an excellent market for canned goods in England. From what I was able to gather from conversation with prominent and reliable men in the business, I believe that it is possible for Canadian manufacturers to develop a very profitable business along this line. But in order to achieve the highest degree of success we must pay special attention to the following points: Our goods must be put up in the most attractive style. The cans must be neatly made, and the labels must be placed properly on the cans. (Appearance counts for a great deal in England). The goods exported must be of the very best quality if we are to compete successfully with our American neighbors. The goods should also be packed so as to prevent, in so far as possible, any injury to the cans. A final point, which of course is demanded in all lines of business, is to fill all orders promptly.

Investigations Undertaken.

The most important line of investigation to which I am devoting my attention is the question of the digestibility and relative food values of the different forms of cattle foods. Our equipment for carrying on this line of work is inadequate, but we hope that the results obtained may demonstrate the necessity of a more liberal grant for this line of investigation.

The second line of investigation upon which I am engaged is the analysis of the ash of our farm crops,—cereals, legumes, and tubers. The object of this work is twofold: First, to compare the different methods which have been suggested, and second, to study the distribution of the ash in the leaves, stems, and grains of our farm crops.

Miscellaneous.

In the spring of the present year we prepared one gallon of standard alkaline solution for each of the instructors of the Western Dairymen's Association.

Recently I have made a chemical examination of several samples of canned fruits, to determine whether or not preservatives had been used in the process of manufacture.

Before concluding this brief report, I wish to thank you for leave of absence during the past summer, by reason of which I was enabled to travel and study agricultural conditions in the Old Land. I believe that the information gained by visiting various stations in England and on the Continent has been of material aid to me, both in the class-room and the laboratory.

Respectfully submitted,

W. P. GAMBLE.

PART VII.

THE PROFESSOR OF VETERINARY SCIENCE.

To the President of the Ontario Agricultural College:

SIR,—In submitting my report for 1903-1904 allow me to extend to you my congratulations upon your appointment to the presidency of the college after the resignation of the late president Dr. Mills.

CLASS ROOM.

The class-room work in my department has been much the same as in former years.

First year. During the fall term I gave to this class a course of lectures and demonstrations on Comparative Anatomy. This included a brief but comprehensive consideration of the skeleton, joints and muscular system; the digestive, respiratory, urinary, and generative organs; the ciruclatory and absorbent system; the eye, skin, and foot; and the nervous system, of the horse. Where possible we verified description by the examination of the skeleton and the living animal, and made all points as plain and practical as possible. Where important differences exist between the anatomy of the horse and other animals, notice was taken of the same.

During the afternoon lectures we discussed the erection of horse stables, as regards site, material, drainage, ventilation, kinds and arrangement of stalls, both single and box, feed boxes, mangers, floors, etc.; the general care of horses as regards feeding, watering, grooming, handling colts, educating them to drive, working and exercising them etc.; the general care of harness, saddlery, carriages etc. In addition to this I gave a course on Judging Horses. In this course we were, as in former years, badly handicapped in not having individuals of the different breeds and classes for demonstration and comparison. I used those we have, borrowed some, and supplied some from my own stable.

During the winter term I gave a course of lectures on Veterinary Materia Medica, in which I spoke of the properties, actions, uses and doses of the different medicines and remedies used for the prevention and cure of the ordinary diseases of domesticated animals. We also discussed the different methods of administering and applying medicines, with the advantages and disadvantage of each.

Second year. The fall term class-room for this class consisted in the consideration of the causes, symptoms, and treatment (both preventive and curative) of the ordinary diseases of farm stock, with frequent reference to the proper mode of feeding, watering, and general care of stock in order to prevent disease.

During this course I usually have a living horse in the class-room, and explain the different appearances of an animal in health and disease; point out the seat of disease when possible, and illustrate with specimens of diseased bone, etc., the changes of structure that occur during disease.

During the winter term I gave a course of lectures on Veterinary Obstetrics, treating on the phenomena of reproduction, the development of the foetus, the usual causes of sterility, and the methods by which some of them can be removed; the diseases of both sexes due to the act of reproduction; the general hygienic treatment of pregnant females, the phenonema of parturition, the manner of treating cases of difficult parturition, the causes, symptoms and treatment of diseases of both dam and offspring incident to and following delivery, and gave special attention to the care of the young. As far as possible I illustrated these lectures with charts, diagrams, etc.

During the afternoons I gave a course of lectures and demonstrations upon the practical methods of handling horses, securing animals for minor operations, as opening abscesses, dissecting out tumors, dressing and stitching wounds, castrating, firing spavins, ringbones, etc. I illustrated the different methods of applying bandages, stitching wounds, dressing teeth, administering medicines, scarifying lampas, passing a probang in the ox, puncturing in case of excessive bloating, etc.

In addition to the above I continued the instruction in judging horses commenced in the first year.

Third and Fourth Years. With these years I continued the course in judging horses, using those at our disposal, and visiting the establishments of local breeders and dealers.

Dairy Class. To the special dairy class I gave a short course of lectures on the courses, symptoms, and treatment (both preventive and curative) of the ordinary diseases of dairy cattle.

Short Course in Stock Judging. This was held in January, and to its members I gave a course of practical illustrations in judging the different breeds and classes of horses. I was ably assisted in the draught classes by Robt. Ness, Esq., of Howick, Que. In this, as in the regular classes, we were badly handicapped by the absence of horses suitable for the purpose. We have in the farm stables a few fair representatives of the Agricultural horse, but not even a fair individual of any other class. I borrowed for the purpose suitable animals from the citizens of Guelph and from local breeders and dealers. I wish to take this opportunity of publicly expressing our gratitude for the kindness of the following gentlemen in providing us with subjects for comparison and discussion, viz., Messrs. Sorby, McCannell, Bowman, Atchieson, McKenzie, Tovell, Hales, Hurley, Stewart, Dr. Short, of Erin, and others. These gentlemen not only allowed us the use of their horses, but brought them to the class-room and good naturedly listened to the severe and often unjust criticisms to which they were subjected. The pavilion erected for the purpose affords good accommodation for the class and the horses, but it is not possible to show action properly in so small a ring, and when the weather is severe and the snow deep, as it was last January, we cannot take the animals outside to show action with any degree of satisfaction. In order to enable a horse to show action it is necessary to have a straight away track for 100 yards or more. We may look forward to the time when we will have a covered runway for this purpose. I would like to again draw the attention of the department to the facts already noted, viz., the absence at the institution of horses suitable for class-room purposes. We have not a pure-bred horse in the stables, nor even a fair representative of any class except the agricultural. For the special classes it is possible to borrow, but for the regular classes this is impracticable, as we cannot ask our friends and neighbors to be continually supplying us. In other classes of stock, it is very different. In cattle, sheep, swine and poultry there are a few pure-bred animals of most of the popular breeds.

Diseases of Stock. Besides class-room and practical work I gave professional attention to all the stock, and am pleased to be able to state that the losses were comparatively few.

Horses. We had several cases of the ordinary ailments in horses, viz., colic, indigestion, influenza, lymphangitis, calks, wounds, sore necks and shoulders, oedema, eczema, etc., all of which yielded to treatment. The President's mare broke her leg on the slippery roads in the latter part of the winter, and as there was no possibility of successful treatment she was destroyed. An old mare belonging to the Experimental department became useless, and practically helpless from old age, and she was destroyed.

Cattle. We had several cases of retention of the placenta, maminitis, sore teats, impaction of the rumeu, fardel bound, and other forms of indigestion, diarrhoea, constipation, uterine discharge, pyaemia, etc., all of which recovered. We had two cases of parturient apoplexy, commonly called "milk fever, one of which I treated by inflating the udder with oxygen gas, and the other with sterilized air. Both made rapid and perfect recoveries. We had a fatal case of inflammation of the womb in a Holstein cow of the dairy herd.

Sheep. We had little trouble with sheep. We lost one ewe from scirrhus of the liver, and a few lambs from wool balls in the fourth stomach.

Swine. We had little disease, and no losses in swine except in newly born pigs.

Respectfully submitted,

J. H. REED, V.S.

PART VIII.

THE PROFESSOR OF DAIRY HUSBANDRY.

To the President of the Ontario Agricultural College:

SIR,—I beg leave to submit my fourteenth annual report of the Dairy department of the College. The year has been a successful one. Our milk supply is now larger than it has ever been, and we hope during the coming year to place our Dairy department upon a commercial basis so far as our supply of milk farmers is concerned. This can be done by purchasing the milk outright as we have been doing, or we may make a charge of so much per pound for manufacturing cheese and butter, such as is done in ordinary cheese factories or creameries. We have paid for milk and cream during the past season about $15,000. As our supply is increasing all the time, if we continue to purchase the milk we shall have to ask for a larger appropriation under this head. Our products now have a good reputation, and we can sell our manufactured goods at a price slightly above that obtained in the regular way. However, we have quite a heavy loss each year with milk, cream, cheese, and butter used for experimental purposes, for which there is sometimes little or no revenue, but we have valuable information for dairymen as a result of these experiments. There is also considerable extra expense and loss of product in teaching students practical dairying. Larger buildings, extra machinery and extra men are needed to give practical dairy instruction, so that it is doubtful if we shall ever be able to put the department on a paying basis in the ordinary sense of that term, but we are aiming at *economy consistent with the highest proficiency.*

IMPROVEMENTS.

A great many improvements have been made during the year. New cement floors have been laid throughout the dairy stable, also cement floors in the separator room of the dairy, the basement of the farm dairy and milk-receiving room of the cheese department. The steam boilers have been rebricked, new steam pipes have been carried to the new dairy building, the system of heating changed to "low pressure," a new engine has been put in the dairy and the exhaust steam is now all utilized for pasteurizing skim-milk heating water, or heating the building. The buildings have been painted throughout on the inside, with the exception of the cheese room. An electric motor for cutting feed and pulping roots has been placed in the barn. You will thus see that it has been a year of rather extensive improvements, and our expenditure has been rather heavier than usual, but we feel that we have been amply repaid in extra conveniences and economy in manufacturing, to say nothing of improvement in appearances.

We still need our dairy stable properly ventilated, a weighing porch for the cheese room, and cement walks about the dairy. In the near future we shall need to provide a special branch for market milk. The demands upon our space and men in the preparation of milk and cream for the College, Macdonald Hall, and sundry customers is becoming too great to be carried on as we have been doing. We have furnished the College about $1,300 worth of milk and cream this past year. Add to this the amount which is being sent to Macdonald Hall, and sold to officers and employees of the College, and you will see that this work alone is almost sufficient to keep one person employed for about seven months of the year.

I am much indebted to Messrs. Stratton and Taylor in the dairy, Mr. Wood in the stable, Miss Frew, accountant and librarian, and to the Instructors in the Dairy School for their help and co-operation during the year.

The Dairy School.

In addition to the course of lectures and practical work given to the regular College Classes, we have had five special courses in Dairying during the year, attended by ninety-three students. The attendance has not been so large as usual. One reason was that the special lectures in Domestic Science were discontinued, as this work is now provided for at the Macdonald Institute. The Institute also took a considerable number of lady students who preferred taking Domestic Science, including Dairying, rather than Dairying, including Domestic Science. It is to be expected that young ladies would prefer a short course at the Institute where they have the privilege of taking Dairying as an optional subject, rather than devoting all or nearly all their time to dairy work.

Another reason for the smaller attendance is probably to be found in the fact that most of the factory cheese and butter makers have now attended a course in dairying at one of the three well equipped schools of the Province, and, as the field is somewhat limited, we may expect the attendance to be smaller than has been the case in the past.

With smaller classes we hope to be able to do better work. A class of twelve to fifteen students is all that one Instructor can properly look after, while at practical work a class of twenty or twenty-five is more than one person can adequately instruct.

We are improving our equipment and methods of instruction each year, and consider that the School was never in a position to do such good work as at the present time. Our dairy herd, dairy stable, and farm dairy are features which should especially appeal to men and women on the farm who wish to obtain the latest and best information regarding farm dairy work.

As in former years, we are indebted to Professors Harrison and Gamble for their valuable help and co-operation in bacteriological and chemical work. Our students, especially those taking the Instructor's course, are beginning to appreciate the value of this work in assisting them to solve practical difficulties in the factory and on the farm.

Experiments in Cheesemaking.

Owing to the large amount of extra work involved in making the changes and improvements in the dairy during the past year, we were unable to accomplish as much experimental work as in former years.

The work in cheesemaking related to the following: Different quantities of rennet for cheese ripened in cold-storage; Rennet and Pepsin as coagulating agents; Ice and mechanical cold-storage for ripening cheese; various temperatures for ripening cheese between 28 degrees F. and 55 degrees F.; Moisture in curd and cheese; and Boxing cheese directly from the hoops compared with boxing cheese one week after placing them on the shelf. We found it somewhat difficult to maintain the temperatures aimed at in the various rooms.

All the cheese were judged according to the following scale of points: flavor 40, closeness 15, even color 15, texture 20 and finish 10, total 100. All the cheese were given 10 points for finish. The final scoring was made by Mr. I. W. Steinhoff of Stratford on December 10th.

Rennet *vs.* Pepsin.

Several firms are now recommending the use of pepsin instead of rennet as an agent for coagulating milk for cheese making. We have used two different brands for experimental purposes during the past season. One was supplied by Armour & Co. of Chicago, and the other by Frank L. Jones of Utica, New York. It is claimed that a better quality of cheese can be made by using the pepsin instead of the rennet.

The rennet used was Hansen's Extract. The quantity was 3⅓ oz. per 1,000 lbs. milk. The pepsin is in the form of scales which are brought into solution by dissolving one ounce (about 28 grams) in 20 fluid ounces of water. It was recommended by the firms supplying the pepsin to use of this solution about the same quantity as of rennet. We found, however, that 3⅓ oz. of this solution per 1,000 lbs. milk took too long to coagulate the milk, and it was necessary to add double this amount, or 6⅔ oz. in order to obtain satisfactory coagulation. The coagulum does not in any case appear to have the same firm character as does that of milk coagulated with rennet. The acid also appears to develop faster in the curds from the rennet.

During the month of August eight experiments were made. Altogether we used 4,800 lbs. milk testing an average of 3.57 per cent. fat. For each test 300 lbs. milk were coagulated with rennet and 300 lbs. with pepsin. The average percentages of acidity at dipping, milling and salting were .194, .928, and 1.166 for the rennet lots, and .194, .902, 1.130 respectively for the lots in which pepsin was used. The average percentage of fat in the whey was .215 for both lots.

Table showing quality of Cheese made with Rennet and Pepsin.

Kind of Cheese.	Scorer.	Flavor. Max. 40. Av.	Closeness. Max. 15.	Even Color. Max. 15.	Texture. Max. 20.	Total. Max. 100.
Rennet.....	Dairy	36	13.8	14.1	17.7	91.7
Pepsin	"	36	14.0	14.0	18.0	92.0
Rennet.....	Mr. Steinhoff	34.9	14.3	14.0	16.0	89.2
Pepsin	"	35.5	14.2	14.0	16.0	89.7

Conclusions. 1. It is more difficult to prepare the pepsin solution ready for use. Usually about one-half hour is required to bring it into solution, and just enough must be prepared at one time as it quickly spoils after being added to water. The cheesemaker would object to the use of pepsin on this account, as he is usually very busy about the time, "the vat is ready to set."

2. The 2,400 lbs. of milk in which rennet was used produced 231.45 lbs. green cheese and 220 lbs. cheese weighed at the end of one month after making. The cheese lost 4.9 per cent. in weight during one month. The same weight of milk with pepsin gave 231.02 lbs. green cheese, and 218.75 lbs. cheese weighed at the end of one month. These lost 5.3 per cent. in weight in one month. The average yield of marketable cheese per 1,000 lbs. milk was 91.6 lbs. from the rennet, and 91.1 lbs. from pepsin, or about one-half pound less.

3. The quality of the cheese was slightly better by using the pepsin. The average of all scorings for flavor was 35.5 out of 40 for the rennet cheese and 35.8 for the pepsin cheese. The averages of the total scores were 90.7 and 91.1 for rennet and pepsin respectively.

Moisture in Curd and Cheese.

These experiments are a continuation of those made last year. Four tests were made in July. Six hundred pounds of milk were used for each test. The whole milk was first mixed, then divided into two lots of 300 lbs. each. The percentage of fat in the milk averaged 3.7. The cheese marked A were designed to contain an excessive amount of moisture, and the B cheese were made with a normal amount of moisture in the curd and cheese.

Table of Moisture and Acidity.

	"A" cheese containing excessive moisture.	"B" cheese containing normal moisture.
Moisture at dippidg	57.377	54.431
" " milling	42.438	40.965
" in green cheese	35.979	34.571
Acid at dipping	.171	.178
" " milling	.852	.795
" " salting	1.160	1.090

The cheese were scored on Sept. 20th, and again by Mr. Steinhoff on December 10th.

Table Showing Quality of Cheese.

Method of Ripening.	"A" cheese—excessive moisture.			"B" cheese—normal moisture.	
	Scorer.	Av. Flavor. Max. 40.	Av. Total. Max. 100.	Av. Flavor. Max. 40.	Av. Total score Max. 100.
Mech. storage, 40° F.	Dairy	38	95	38	95.5
	Mr. Steinhoff	36	90.7	36.2	90.7
Ice storage, 40° F.	Dairy	37.5	93.5	37.5	94.1
	Mr. Steinhoff	36.5	90.2	36.7	91.2

Conclusions.

1. The cheese with extra moisture contained about three per cent. more moisture at dipping, one and one-half per cent. more at milling, and one and a half per cent. more in the green cheese. The acidity was also slightly greater at milling and salting in these cheese. The increased moisture caused an increased yield of marketable cheese equal to about one-half pound per 1,000 lbs. milk.

2. There was little difference in the quality of the cheese. From two years experiments we may conclude that an excess of one to two per cent moisture may be left in cheese ripened in cold-storage without much danger of the quality deteriorating, although the normal cheese scored slightly better.

3. The cheese with an excessive amount of moisture lost 4.2 per cent. during one month in mechanical storage and 3.9 per cent in ice storage. The normal cheese lost 3.6 and 3.3 per cent. respectively. The normal cheese lost less during one month. The loss in weight was also less in the ice storage than in mechanical cold-storage.

Extra Rennet for Cheese Ripened in Cold-Storage.

It is now accepted as a truth that rennet has an important influence on the ripening of cheese. It is also conceded that an extra amount of rennet will cause the cheese to ripen more quickly. For cheese ripened at 70 degrees or above, an extra amount of rennet is not advisable, as there is danger of bad flavor and weak body in the cheese. In cold-storage, however, it may be desirable at times to hasten the ripening process by using more rennet than usual.

The following experiments are a continuation of last year's work. During August and September seven lots with normal rennet, (3 1-3 oz., per 1,000 lbs. milk) and seven lots with 6 2-3 oz. per 1,000 lbs. milk were ripened in mechanical cold-storage at about 40 degrees F. During the same months six lots with similar quantities of rennet were ripened in the ice cold-storage at about 40 degrees F. The average percentage of fat in the milk for all the lots in mechanical storage was 3.6, for those in ice storage the average was 3.8. The average acidity of the milk was .19 at the time of adding the rennet. The per cent. fat in the whey averaged .21 for both lots in both places of ripening. In all cases the milk was first mixed, then divided into two equal parts of 300 lbs. each. The rennet was then added at the rate of 3⅓ oz. per 1,000 pounds of milk to one vat and 6 2-3 oz. to the other. All other parts of the work were as nearly alike as possible.

The total yield of green cheese from 2,100 lbs. milk to which 6 2-3 oz. rennet per 1,000 lbs. milk were added, was 201.63 lbs. The weight of cheese at the end of one month was 194.13 lbs. ripened in mechanical storage. The per cent. lost in weight during one month was 3.71. The yield of green cheese from the same weight of milk to which 3⅓ oz. of rennet per 1,000 lbs. milk was added, was 201.95. The weight at the end of one month was 194.38. These cheese lost in weight 3.74 per cent.

In ice storage the yield of green cheese from the excess of rennet was 178.88 lbs. from 1,800 lbs. milk. The weight at the end of one month was 173.94 lbs., having lost 2.7 per cent. in one month. The green cheese from normal rennet weighed 178.7 lbs. At the end of one month they weighed 174.06, having lost 2.6 per cent in the month.

Table Showing Quality of Cheese made from 6⅔ oz. and 3⅓ oz. rennet per 1,000 lbs. Milk.

Kind of cheese and method of ripening.	Scorer.	Average Score.				
		Flavor. Max. 40.	Closeness M. 15.	Even color. M. 15.	Texture. M. 20.	Total. M. 100.
6⅔ oz. rennet, Mech. Stor.	Dairy	38.2	14.2	14.4	18.8	95.8
3⅓ " " " "	"	38.2	14.0	14.2	18.8	95.4
6⅔ " " Ice "	"	37.5	16.6	13.8	18.8	93.8
3⅓ " " " "	"	37.6	13.8	14.0	18.8	94.3
6⅔ " " Mech. "	I. W. Steinhoff	37.2	14.0	14.1	18.0	93.3
3⅓ " " " "	"	37.3	14.1	14.1	18.1	93.8
6⅔ " " Ice "	"	36.5	14.8	14.1	18.2	93.0
3⅓ " " " "	"	37.8	14.0	14.1	17.9	92.9
6⅔ " " " "	Av. all scores	37.0	13.8	14.0	18.5	93.4
3⅓ " " " "	"	37.2	13.8	14.0	18.3	93.6
6⅔ " " Mech. "	"	37.7	14.1	14.3	18.4	94.6
3⅓ " " " "	"	37.8	14.0	14.2	18.4	94.6

Conclusions.

1. There was little or no difference in the yield of cheese whether 6⅔ oz. rennet or 3⅓ oz. of rennet per 1,000 pounds of milk were used.

2. The cheese ripened in mechanical storage lost about one per cent. more in shrinkage during one month than did those ripened in ice storage. The shrinkage was practically the same with the large and normal amounts of rennet.

3. There was little or no difference in the quality of the cheese whether a large or normal amount of rennet was used.

4. The cheese averaged slightly better in quality from those lots ripened in mechanical cold storage, but lost more in weight as compared with ripening in an ice storage.

5. In cases where cheesemakers wish the cheese to ripen more rapidly than usual, after placing in cold-storage, an excessive amount of rennet may be safely used, although it is not likely to produce any more cheese nor make any better quality of cheese.

Placing Cheese on Shelves *vs.* Boxing directly from the Press.

This is a continuation of last year's experiments on this question. Its practical bearing lies in the direction of reducing the labor involved when moving cheese from the ordinary curing-room to a consolidated curing-room or cold-storage If the cheese may be boxed at the factory and be allowed to remain in the boxes after reaching the cold storage it means a great reduction in labor and expense.

Between June 23rd and July 6th, four lots were ripened in mechanical cold-storage and five lots in an ice storage. Altogether, 12,626 pounds of milk testing an average of 3.58 per cent. fat, were used for the experiments. The average amount used for each test was 1,400 pounds milk. After salting, the curd was divided into two equal parts as nearly as possible, and two cheese were made ranging in weight from 62 to 69 pounds each. One cheese was placed on the shelf in the cold storage, and the other was placed directly into a cheese box.

Those placed on the shelf in mechanical storage lost during one month 2.8 per cent. Those in boxes lost 2.4 per cent. in the same time. In the ice storage the loss was 2.1 and 1.2 per cent. respectively.

Table Showing Quality of Cheese placed on Shelves and in Boxes.

Kind of Cheese and method of ripening.	Scorer.	Average score of the Cheese.				
		Flavor. Max. 40.	Closeness. M. 15.	Color. M. 15.	Texture. M. 20.	Total. M 100.
Ripened on shelf in M.S..	Dairy.	38	14.5	15	19	96.5
" in box " " ..	"	38	14.5	15	19	96.5
" " " in ice...	"	37.8	15.0	15	18.2	96.0
" on shelf " " ..	"	37.4	15.0	15	18.0	95.4
" " " " " ..	Mr. Steinhoff.	36.2	14.5	14.3	16.0	91.1
" in box " " ..	" "	37.1	14.5	14.3	16.2	92.2
" " " " M.S.	" "	37.3	14.5	14.5	16.3	92.7
" on shelf " " ..	" "	37.5	14.5	14.5	16.6	93.1

Conclusions.

1. The cheese on the shelves in mechanical cold storage at 40 degrees F. lost nearly one-half per cent. more in weight during one month than did those in boxes. The loss in the ice storage was nearly one per cent. less than in the mechanical storage, and was about one per cent. less on the cheese in the boxes than for those on the shelves.

2. There was not much difference in the quality of the cheese whether ripened on the shelf or in a dry, clean box. The cheese, however, tend to mould much worse in the box, especially in the ice storage.

3. It appears to be quite practicable to place green cheese into boxes without turning them, and placing them in cold-storage until ready to ship.

EFFECT OF FIVE DIFFERENT TEMPERATURES ON CHEESE RIPENING.

These experiments are a continuation of the work done in 1903. Six tests were made during August and September. The total quantity of milk used was 9,827 lbs., or an average of 1,637 lbs., testing 3.8 per cent. fat, for each experiment. After handling the milk and curd in the usual way, the curd was divided among five hoops after salting, having as nearly as possible the same weight of curd in each hoop. The weight of the green cheese was about 30 lbs. each. The five green cheese were then marked and placed in rooms at five different temperatures. We aimed to have these about as follows: ice and mechanical cold-storage at 40 degrees F., mechanical storage at 28 degrees and 50 degrees, and a room in the basement or cellar of the farm dairy at about 55 degrees F.

The cheese were weighed when placed in the different rooms, and again at the end of one month. They were judged on November 11, and again by Mr. Steinhoff on December 10th.

The table is a summary of the main points in the experiments.

Cheese.	Method of ripening.	Av. Temp.	Av. % moisture in room.	% lost during one month.	Average quality of the Cheese.				
					Flavor. Max. 40.	Closeness. Max. 15.	Color. Max. 15.	Texture. Max. 20.	Total. Max. 100.
"A."	Ice Storage.	41.2	87	2.9	38	14	14.3	19	95.3
"B."	Mech. "	39.3	77.7	2.7	38	14.8	15	19	96.6
"C."	Mech. "	42	78.2	3.4	38.1	14.3	14.5	19	96
"D."	Mech. "	31.7	80	2.7	38	14.8	14.6	19	96.5
"E."	Cellar "	51.4	83	4.1	37.6	14	14.5	18.5	94.6
					I. W. Steinhoff's Scores.				
				A.	36.1	14	14.08	17.4	91.6
				B.	36.5	14.08	14	17.4	92.08
				C.	36.8	16.1	14	17.1	92.1
				D.	37	14	14	17	92
				E.	37	14.2	14	17.2	92.5

Conclusions.

1. The higher the temperature of ripening the greater the loss in shrinkage. The loss in the cellar storage at about 51 degrees was from one to one-and-a-half per cent. greater than on those cheese ripened in cold-storage at 40 degrees or below.

2. There is not much difference in the quality of the cheese. Mr. Steinhoff scored those ripened at about 51 degrees slightly higher, chiefly because they had more of the "cheese flavor." The extreme difference in the averages of the total scores of the cheese ripened at the five temperatures is less than one point as given by Mr. Steinhoff. Averaging the two scorings, the cheese ripened in mechanical storage at 40 degrees F. are slightly higher. Here again the extreme difference in quality is represented by less than one point. This was true also in 1903. We may therefore conclude that of the five temperatures for which experiments have been made for two years, there is little difference in the quality of the cheese, though the shrinkage is greater at 50 to 55 degrees than at 40 degrees. However, it will cost more to maintain a temperature of 40 degrees than of 50 to 55 degrees F., hence it would seem that the latter is a very favorable temperature at which cheese may be ripened.

Ripening Cheese in Ice and Mechanical Cold-Storage.

Cheese moved from Ordinary Ripening room to Cold-storage at end of one week.

This is a continuation of the work done last year, with this difference, the lot ripened for the full period in the ordinary ripening room was dropped out, and moving the cheese at the end of one week to mechanical storage was substituted. As it had been demonstrated in previous years that the cheese ripened in the ordinary room was inferior in quality to those ripened in cold-storage, it was not considered necessary to continue this portion of the experiment.

From June 9th to Sept. 26th, thirteen lots of cheese were made. Altogether there were used 22,942 lbs. milk testing an average of 3.6 per cent. fat. A vat of milk, averaging 1,639 lbs., was handled in the usual way until the curd was ready for hooping. It was then divided into five cheese weighing about 30 lbs. each.

The chief points in manufacture were: the acidity of the milk at the time of adding the rennet was about .2; the temperature for cooking the curds 100 degrees F.; the average per centages of acidity at dipping, milling, and salting were respectively .201, .797 and 1.07; the rate of salting was 2½ pounds per 100 lbs., curds; the curds were put to press at temperatures ranging from 80 to 85 degrees F.; the curds were pressed in an ordinary gang press for about twenty hours, when they were taken from the hoops, weighed, and marked before placing in the ripening rooms.

Two of the cheese were placed in the ordinary ripening room where the temperature averaged about 65 to 70 degrees F. At the end of one week, one of the cheese was moved to an ice storage where the temperature was about 40 degrees F., and the other was placed in mechanical storage where the temperature was also about 40 degrees F. The other three cheese were placed directly from the hoops in cold-storage—one in an ice storage at 40 degrees F., one in mechanical storage at 40 degrees F. and the other in mechanical storage at about 42 degrees F. The cheese were scored about once a month during the season. The last score was made by Mr. Steinhoff, of Stratford, on December 10th, 1904. Our ice storage is on the Hanrahan system, where the cold air circulates from the ice to the storage without having to move the ice. The mechanical storage is the Linde circulating cold air system, using ammonia as the refrigerating agent.

The chief object of the experiment was to note whether or not cheese may be safely left in an ordinary room for one week before moving them to ice or mechanical cold-storage or "cool-curing rooms." If cheese may be allowed

to remain at ordinary temperatures for one week before moving them to central stations to finish the ripening process, it would lessen the expense of removal as compared with moving them daily, especially for small factories.

TABLE SHOWING PER CENT. IN WEIGHT LOST DURING ONE MONTH, AND ALSO QUALITY OF CHEESE.

Method of ripening cheese.	Scorer.	Per cent. shrinkage.	Average Scores.				
			Flavor. Max. 40.	Closeness. Max. 15.	Color. Max. 15.	Texture. Max. 20.	Total. Max. 100
Ice storage, at 40° F.....	Dairy.	3.4	37.20	14.10	14.90	18.50	94.80
" "	Mr. Steinhoff.		36.40	14.20	14.08	17.00	91.70
" "	Av. of all.		37.08	14.18	14.75	18.23	94.25
Mech. storage "	Dairy.	3.7	37.60	14.08	14.80	18.50	95.08
" "	Mr. Steinhoff.		36.70	14.30	14.20	17.08	92.40
" "	Av. of all.		37.40	14.10	14.70	18.20	94.50
" at 50° F.....	Dairy.	4.2	37.40	14.27	14.90	18.30	94.90
" "	Mr. Steinhoff.		37.00	14.10	14.10	17.08	92.40
" "	Av. of all.		37.30	14.20	14.70	18.08	94.40
" @ 40° at end of 1 week ...	Dairy.	4.1	37.50	14.10	14.70	18.40	94.79
" " at end of 1 week ...	Mr. Steinhoff.		37.00	14.20	14.08	16.90	92.20
" " at end of 1 week ...	Av. of all.		37.40	14.10	14.60	18.10	94.28
Ice storage @ 40° at end of 1 week.	Dairy.	3.4	37.40	13.89	14.90	18.40	94.70
" @ 40° at end of 1 week.	Mr. Steinhoff.		36.90	14.20	14.10	16.80	92.10
" @ 40° at end of 1 week.	Av. of all.		37.30	13.90	14.80	18.10	94.20

Conclusions.

1. The cheese in mechanical cold-storage lost the greatest percentage in weight. Those in the room at 42 degrees F. lost an average of 4.2 per cent., while those in ice storage at 40 degrees F. lost 3.4 per cent. in one month. Those moved at the end of one week from the ordinary room to mechanical storage at 40 degrees F. lost 4.1 per cent., while those in the mechanical storage from the first lost 3.7 per cent. Those moved in one week to the ice storage apparently lost no more than did those placed in the ice storage directly from the hoops. As in nearly all the experiments, the shrinkage of the cheese was less in the ice storage than in the mechanical storage, and the higher the temperature the greater was the shrinkage. The shrinkage was also greater on those left in the ordinary room for one week before moving to mechanical storage.

2. There was little or no difference in the quality of the cheese in the five lots. The difference in the average total score was less than one point in the five lots. This is seen by comparing the average scores as given by Mr. Steinhoff which were as follows: 91.7, 92.4, 92.4, 92.2, and 92.1. The average of all scores was 94.2, 94.5, 94.4, 94.2. We may judge that so far as quality is concerned cheese may be moved once a week from the ordinary room to cold-storage or "cool-curing" rooms.

EXPERIMENTS IN BUTTER-MAKING.

The experiments in butter-making during the past year have related to: the pasteurization of whole milk compared with the pasteurization of cream;

the churning of sweet cream containing 20 to 30 per cent. of pure butter culture compared with the ripening of cream; the churning of sweet cream with and without a butter culture; the use of dry and wet parchment paper for lining butter boxes and wrapping pound prints; ice and mechanical cold storage for butter; preservatives in butter; and a comparative test of eight hand cream separators.

All but the last two experiments are here reported upon in more or less detail. The results of the tests with various preservatives other than salt, and compared with salt, will be reported in a special bulletin by the Dairy and Chemical departments early in 1905. We have not sufficient data as yet with reference to the hand separators. Nearly all the machines did very good work under the conditions of the tests made. A dairyman would make no serious mistake in purchasing any one of the leading makes of separators. It is largely a question of price, capacity, and individual preference.

The samples of butter in all cases were judged on the basis of the following scale: Flavor 45; Grain 25; Color 15; Salting 10; Package 5; Total 100.

Pasteurizing Milk *vs.* Pasteurizing Cream.

During the month of August four trials of pasteurizing milk were made to compare with the pasteurization of cream. About three thousand pounds of milk were mixed in a vat. One-half of the milk was pasteurized at 180 to 190 degrees F., before separating. The other half of the milk was heated to about 90 degrees before separating, and the cream was afterwards pasteurized at 180 degrees to 190 degrees F. The order of pasteurizing the milk and cream was reversed for each experiment, i.e., if the milk were pasteurized first one time, the cream was pasteurized first next time in order to overcome any differences there might be as a result of holding the milk in the vat.

Both boxes and pound prints of butter were made in each experiment, and placed in storage at about 40 degrees F. The samples were scored about once a month until November 26th, when the last scoring was made. The average of all scores for flavor was 36.7 for the lots made from pasteurized whole milk and 36.4 for the pasteurized cream. The total scores averaged 91.5 and 90.4 respectively.

Conclusions.

The experiments are not sufficient in number to warrant us in drawing hard and fast conclusions, but they point to the fact that when first made there is little or no difference in the quality of the butter in summer whether the whole milk or cream be pasteurized, but that the butter holds its flavor slightly better when made from pasteurized milk as compared with pasteurized cream. However, the extra labor involved in cleaning the separator bowl when separating pasteurized milk probably counterbalances any difference in quality. By using "exhaust" steam for pasteurizing the skim-milk the cost of pasteurization is not very great.

Sweet Cream with Culture *vs.* Ripened Cream.

Four trials were made during July and August comparing the churning of cream immediately after separating, pasteurizing, and cooling, with churning cream from the same vat after ripening in the usual way. The cream was first thoroughly mixed in the cream vat; then one-half averaging 35½ lbs. cream for each churning, was put in a combined churn and worker, an average of 27½ per cent. of butter culture was added and the cream was churned immediately at an average temperature of 54.2 degrees F. The average time re-

quired to churn was 17 minutes. The percentage of fat in the buttermilk averaged .6. The yield of butter was 126.6 pounds per churning. The butter scored an average of 39.5 points (max.45) for flavor and a total of 94.3 points. The samples in all cases were scored about once a month until the end of November.

The ripened cream (351½ lbs.) had 56 per cent. of acid when churned at an average temperature of 50.5 degrees. The time required to churn was 23½ minutes, and the percentage of fat in the buttermilk averaged .28. The yield of butter averaged 127.6 pounds. The average scores for flavor and total were 36.8 and 91.8.

The total yield of butter from the sweet cream for the four churnings was 506.7 pounds and for the ripened cream it was 510.6 or 4 pounds more.

Three lots of this butter made July 21, August 23 and 24 were sent to Montreal in November for scoring by experts in the trade, and by Mr. Woodard, "Official Referee." In addition, two boxes made in April, which had been kept in cold-storage at 40 degrees F., and which had been scored by Mr. Woodard soon after making, were also sent. Mr. Woodard scored the sweet cream butter made in April, when fresh, 42 out of 45 for flavor, and a total of 94 points. The butter made from ripened cream scored when fresh 41.5 for flavor and 93.5 for total. On November 2nd these two lots were again scored by Mr. Woodard, when they received 35 and 20 points respectively for flavor in the sweet and ripened cream boxes.

The average of five scores of the July and August butter made on November 2nd by Messrs. Woodard, Vaillancourt, Olive, Ayer, and Le Clair was 40.6 for the sweet cream and 34.9 out of 45 for the ripened cream. All three lots made from the ripened cream were pronounced "fishy".

Conclusions.

1. The yield of butter was slightly less by churning the cream sweet.
2. The loss of fat in the buttermilk was greater from the sweet cream.
3. The time required for churning the sweet cream averaged six minutes less than that for the ripened cream, though this may be accounted for by the fact that the churning temperature averaged four degrees higher.
4. The quality of the butter was superior from the sweet cream with culture, not only when first made but it also held its flavor better. The average of the first scores for flavor was 42 for sweet cream and 40.7 for the ripened cream. At the final scoring at the Dairy in November the sweet cream lots averaged 36.7 points and the ripened cream 32 points. The sweet cream lots lost an average of 5.3 points, while the ripened cream lost 8.7 points in flavor. There was a similar difference made by the experts in Montreal in favor of the sweet cream butter to which culture had been added at the time of churning.

Churning Sweet Cream *vs.* Sweet Cream with Culture added.

The object of this experiment was to compare churning sweet cream directly after separating, pasteurizing and cooling with similar cream to which from 20 to 30 per cent. of culture was added before churning.

The tests were made in August, and the last scoring of the butter was made November 26th. The sweet cream with culture was churned at an average temperature of 53 degrees F. and took 17½ minutes to churn. The buttermilk averaged .35 per cent. fat. The sweet cream without culture was churned at an average temperature of 47½ degrees F. in 14 minutes, with an average of .55 per cent. fat in the butermilk.

The average score of the butter made from sweet cream was 40.5 out of 45 for flavor and 94.8 total, out of 100. The butter from sweet cream without culture scored 39.5 and 93.8 respectively for flavor and total.

Conclusions.

1. The sweet cream without culture churned at a lower temperature, in less time and with a greater loss of fat in the buttermilk than did the sweet cream with culture.

2. The flavor of the butter was slightly better as a result of adding the culture.

Dry *vs.* Moist Parchment Paper for Butter.

Several tests were made during the season to determine whether or not it is advisable to line butter boxes and wrap pound prints of butter with dry paper rather than use moist or wet paper. So far as we could judge there was no advantage in using the dry paper. The butter did not keep any better, and it is more difficult to make a neat package with the dry paper as compared with the wet paper. However, those who are accustomed to the use of dry paper consider that it can be used as conveniently and neatly as the wet, and you are saved the labor of wetting the paper.

In any case it is important to use pure water for wetting the paper as there is danger of contamination by using impure water. Paper for lining boxes are best soaked in brine before using. The value of formalin as a preventive of mould on butter is doubtful.

Cold-Storage for Butter.

These tests are a continuation of the work done in 1903. The object was to compare ice and mechanical cold-storage for butter and also to note the effect of storing butter in a moderately cold room (40 degrees F.) for one week before placing at a lower temperature (28 degrees F.)

The ice cold-storage averaged about 40 degrees F.; one room in the mechanical storage was about the same temperature, and the other room averaged about 28 degrees F.

The butter was made in July. It was scored four times between the date of making and November 26th. The butter in ice storage averaged 35.7 points out of 45 for flavor and a total of 90.5 out of 100. Similar butter placed in mechanical storage at 40 degrees F. averaged 36.2 for flavor and 91.1 for total. The butter placed in mechanical cold-storage at 40 degrees F. for one week then moved to mechanical storage at 28 degrees F. averaged 35.7 and 90.6 respectively, while that placed directly in mechanical storage at 28 degrees F. scored an average of 37.2 and 92.1.

The average of all the lots in mechanical storage was 36.3 for flavor and a total of 91.2, which is slightly above the average scores for the butter in ice storage. There was little difference in the quality of the lots at the first scoring which was done about one month after the butter was made.

Conclusions.

1. Mechanical cold-storage at about 40 degrees F. gave slightly better results than ice storage at the same temperature.

2. Better results were got by placing the butter as soon as made into mechanical storage at 28 degrees, than by allowing the butter to remain for one week at the higher temperature (40 degrees F.) before placing at the low temperature.

3. A temperature of 28 degrees F. gave better results than the higher temperature of 40 degrees F. These results agree with those got in 1903.

4. None of the July butter was suitable for table use when examined at the end of November. It does not seem possible to hold butter in cold stor-

age for three or four months and have it retain its fine flavor. The use of preservatives, other than salt, assist in preventing butter in cold-storage going off in flavor.

Blatchford's Sugar and Flaxseed for Cows and Calves.

We receive a great many requests to test various stock foods which are now on the market. Our answer is that we shall take pleasure in testing these on two conditions: 1. That the parties wishing the tests made shall supply the material free of cost to us. 2. That the results, whether favorable or not, shall be published for the benefit of farmers. Some firms are willing to comply with these conditions and some are not.

The proprietors of "Blatchford's Meal" agreed to the conditions named, and a test in February and March was made with both cows and calves. I cannot do better than quote a letter written to J. W. Barwell, Waukegan, Ill., U. S. A., who courteously sent the meal to us for testing, and offered suggestions as to methods of conducting the test.

"Dear Sir,—Replying to yours of the 15th regarding Blatchford's Sugar and Flaxseed Meal, would say that we have now completed the experiments, and are able to give you the results which are as follows: Four comparatively fresh cows were given Blatchford's Meal according to directions in addition to our regular meal ration for the first ten days in February; the average daily yield per cow was 26.7 pounds of milk. For the next ten days Blatchford's meal was withdrawn and the average daily yield was 26.6 pounds. For the remaining nine days in February Blatchford's meal was given added to the meal ration of these same cows, when the average yield was 27.5 pounds.

"As you will see by the figures given, there was a slight increase in the yield of milk when the Sugar and Flaxseed meal was fed, but not sufficient to pay for the cost of the meal.

"Beginning March 1st, one new cow more advanced in lactation, and one of the four which had been milking somewhat longer than the others was fed for ten days on the B. M. in addition to the regular meal ration and the average daily milk yield was 23.6 pounds. For the next ten days without the B. M. the average daily yield was 21.3 pounds.

"Summing up both of the experiments we may say that so far as these results go they do not indicate any particular effect on the milk yield. There was a slight increase in the average daily milk production, but not sufficient to warrant the additional expense.

"In the calf feeding experiment, two calves which were all we had available at the time, were fed for three weeks, beginning March 11th on our regular ration to which was added two handfuls of B. M. One of the calves gained 60 pounds and the other gained 39 pounds in the three weeks. The following three weeks without the B. M., the one gained 40 pounds and the other 31 pounds. The net gain in the three weeks of the two calves fed on Blatchford's Meal in addition to the regular ration was 28 pounds more than the gain in weight when the B. M. was not given. This appears to be a very good showing in favor of your meal, and indicates that it is likely to be a very good food for calves."

Improved Molasses Cattle Food for Milk Cows.

At the request of the Dresden Sugar Beet Co., of Dresden, Ontario, who kindly supplied the meal to us free of cost, we conducted a series of experiments during February, March and April to note the results of feeding to cows in milk their "Improved Molasses Cattle Food", a by-product from the Sugar Beet factory.

During the first half of February when 21 cows were receiving their regular meal ration of 4 lbs. bran. 3 lbs. oats and 1 lb. oilcake in addition to hay, roots, and corn silage, they produced 5,146 lbs. milk containing an average of 3.78 per cent. fat, or 194.51 lbs. fat. During the second half of the month the same cows, for which half the ordinary meal had been replaced by the Cattle Food produced 4,989 lbs. milk, testing an average of 3.62 per cent.fat, and 180.6 lbs. fat. The 21 cows gave 157 lbs. less milk and 13.94 lbs less fat during the second half of the month when half their regular meal ration was replaced with the Cattle Food. This, however, might be due to advanced lactation.

The cows were continued on the Cattle Food as half their meal ration during the month of March and the flow was well maintained, the average per cow being slightly better than for February.

In the the middle of April, thirteen of the cows which had been receiving Cattle Food for the previous two months were put on their regular meal ration of 8 lbs., bran, oats and oil-cake. Five were continued on the Cattle Food to the end of the month.

During the first 15 days of April the 13 cows gave 3,691 lbs. milk, or an average of 284 lbs. of milk per cow. During the second half of the month the same cows gave 3,517 lbs. milk, or an average of 270 lbs. milk per cow when fed on their regular meal ration.

The five cows which were continued through the month on the Cattle Food as half their meal ration gave 1,172 lbs. milk or an average of 234 lbs. per cow during the first 15 days of April. During the second half of the month they gave 1,131 lbs. milk or an average of 226 lbs. per cow. The average shrinkage per cow, on those changed from bran, oats, oil-cake, and Cattle Food *to* bran, oats, and oilcake without the Cattle Food was 14 lbs. in two weeks. The average shrinkage on those continued on the Cattle Food was 8 lbs. per cow in two weeks.

Conclusions.

We cannot do better than quote the concluding paragraph of the report sent to the manager of the Dresden Sugar Beet Co.: "On the whole we are well pleased with the results and think that the "Cattle Food" will be a valuable addition to the foods available for dairymen in the production of milk."

We understand that the "Food" can be sold for about $15 per ton. It appears to have a feeding value about equal to bran and oats. Ground oats usually cost about one cent. per pound or $20 per ton. Bran costs from $14 to $18 per ton. Compared with these foods, if this by-product of the sugar beet factory can be sold for the price named it should prove an economical milk producer for our dairy farmers.

Last year we reported on an experiment with the beet pulp as a substitute food for mangels in feeding cows. One of the conclusions drawn was, "In those districts where beet pulp can be got fresh from the factory, or if it be stored in a silo, it may well be used as a substitute for roots in the ration for cows giving milk."

Dairy Herd.

The herd on December 31st, 1904, consisted of: 9 Holstein cows, 2 heifers, 4 heifer calves and 1 bull calf; 3 Ayrshire cows and 2 heifers; 4 Jersey cows, 1 heifer and 1 bull calf; 5 Grade Holstein cows; 1 Grade Jersey cow; 4 Grade Ayrshire cows, and 2 Grade Holstein heifers, making a total of 39 head.

As usual we have weighed each cow's milk morning and evening, and have taken composite samples for testing for fat. In addition, we have kept account of the feed. Not all the feed has been weighed, but this has been done frequently enough to know quite closely what each cow has consumed. A sheet showing the amounts of the different kinds of feed consumed by each cow was handed into the office monthly by the herdsman. The feed was charged at the following prices: Straw $2 per ton; hay $6 per ton; corn silage $1.50 per ton; mangels 7 cents per bushel of 60 pounds; bran $16 per ton; oats $20 per ton; oil-cake $28 per ton, and pasture at $5 per cow for the season.

Most of the milk produced by the herd is sold at four cents per quart to the College, Macdonald Hall, and to customers who come to the dairy for the milk. In calculating profit on milk we have credited the cows at the rate of $1.60 per 100 lbs. which is practically four cents per quart. The profit on milk-fat is based on the prices paid to patrons of the College Creamery during the past year, viz., 25 cents per pound fat for the months of January, February, March, and December, and 20 cents per pound of fat for the remaining eight months of the year.

The table shows the main points in the record of each cow for the past year. The rank of the cows has been arranged according to the quantity of milk given, although they might have been arranged according to yield of butter, profit on butter, or profit on milk over the cost of feed. No attempt has been given to charge the labor to the cows. Under ordinary circumstances the value of the manure and skim-milk would pay for the cost of the labor. Neither have the cows been credited with any value for offspring.

Rank.	Name or No. of cow.	Age—years.	Breed.	Live Weight.	No. of days milking.	Lbs. Milk.	Av. % fat.	Lbs. fat in milk.	Lbs. butter.	Value fat.	Valuemilk.	Cost of feed.	Profit on— Fat.	Profit on— Milk.
1	Dolly, 17.....	8	Gr. Holstein...	1436	296	9161	3.5	327.05	381.55	68.15	146.57	28.80	39.35	117.77
2	Mercena, 38 ...	7	Holstein.....	1158	289	8634	3.4	298.	347.7	64.38	138.14	32.23	32.15	105.91
3	Mary C., 15....	7	"	1347	311	7677	3.2	249.5	291.1	54.70	122.83	30.11	24.59	92.72
4	Daisy of R., 41.	7	"	1010	226	7580	3.	225.7	263.3	50.38	121.28	23.75	26.63	97.53
5	Molly, 21	8	Gr. Holstein...	1325	250	7156	3.6	262.3	306.1	56.47	114.49	27.30	29.17	87.19
6	Beauty of N., 67	10	Holstein.....	1100	280	7139	3.5	250.6	292.3	55.78	114.22	30.86	24.92	83.36
7	Abby M., 56...	3	"	1278	293	6725	4.1	277.	323.2	61.35	107.60	29.97	31.38	77.63
8	Lily, 26.....	6	Jersey	822	353	6414	4.3	276.1	322.1	59.74	102.65	23.08	36.66	79.57
9	Molly De K., 76	3	Holstein.....	1160	273	6217	3.4	213.1	248.6	46.34	99.47	28.51	17.83	70.96
10	Lady Nancy, 66	4	Ayrshire.....	967	366	6035	4.2	258.5	301.6	56.12	96.56	26.01	30.11	70.55
11	20	....	Grade.....	1160	201	5768	3.3	193.3	225.57	41.04	92-28	19.53	21.51	72.75
12	Lady S., 61....	3	Gr. Holstein...	1225	259	5626	3.3	186.8	217.9	40.24	90.01	24.56	15.68	65.45
13	Jean III., 28...	5	Gr. Ayrshire ..	1118	215	5179	3.7	193.8	226.1	39.16	82.86	19.50	19.66	63.36
14	Marg. II., 79..	4	Holstein.....	1176	262	4672	3.3	154.1	179.8	33.73	74.75	26.89	6.84	47.86
15	Rena, 70.....	3	Cross-bred A.-J.	837	236	4025	4.9	199.2	232.4	40.84	64.40	18.85	21.99	45.55
16	Emerald R., 54	7	Jersey	950	233	3960	4.	159.9	186.5	35.05	63.36	16.47	18.58	46.89
17	Lady R., 78....	2	Holstein.....	969	161	3928	3.2	129.6	151.2	28.55	62.84	21.56	6.99	41.28
18	Florence, 44...	4	Gr. Ayrshire ..	1135	209	3902	3.5	136.6	159.3	28.47	62.43	21.54	6.93	40·89
19	Daisy D., 72....	2	Holstein.....	1000	239	3802	3.6	138.7	161.8	28.45	60.83	19.13	9.32	41.70
20	Lucy, 2.....	7	Gr. Holstein...	1197	290	3779	3.7	142.3	166.1	30.94	60.46	22.39	8.55	38.07
21	Lucy II., 71....	2	" " ...	895	162	3559	3.3	117.3	136.8	24.81	56.94	20.09	4.72	36.85
22	Jean IV., 82....	2	Gr. Ayrshire ..	811	236	3472	4.3	150.1	175.2	30.62	55.55	16.82	13.80	38.73
23	Glen Bessie, 65.	4	Ayrshire.....	1065	178	2596	3.9	102.9	120.1	21.66	47.53	20.67	.99	26.86
24	Lilac, 75.....	2	Jersey	800	204	2515	4.4	111.5	130.1	24.12	40.24	17.83	6.29	22.41

Comments on Herd Record.

1. As was the case last year, the cow standing at the head of the herd in quantity of milk and butter, and also in profit on milk and butter is a grade Holstein of our own breeding. The cow that was at the head last year has dropped to fifth place this year. The Holsteins are again strong in the lead. One Jersey cow is eighth on the list in quantity of milk, fourth for butter production and second for profit on butter, over cost of feed.

2. Two cows gave yields of over 8,000 lbs. milk, four produced over 7,000 lbs. milk and ten over 6,000 lbs. milk. A larger number than usual in our

herd are heifers with first calf. Some of the cows ought to have made a better record, and unless they produce a larger quantity in 1905, they will be disposed of and their places given to better cows, if they can be got at a reasonable price.

3. The value of the milk from individual cows ranged from $146.57 to $40.24. The value of the milk fat ranged from $68.15 to $21.66. The profit on the milk varied from $117.77 to $22.41. The profit on the milk fat (butter) varied from $39.35 to 99 cents.

4. After production reaches a certain point the cost of feed to produce an increase of 1,000 lbs. milk or 40 to 50 pounds of butter is very much greater. It is a very interesting study to find out how much milk or butter can be *profitably* got from a cow. This requires considerable skill on the part of the feeder. If we were aiming at large records *regardless of cost*, the foregoing records could be increased considerably.

As in former years, we are indebted to the Farm department for pasture, hay, silage, roots, and straw for bedding for our cows.

All of which is respectfully submitted,

H. H. DEAN.

PART IX.

THE PROFESSOR OF ANIMAL HUSBANDRY AND FARM SUPERINTENDENT.

To the President of the Ontario Agricultural College:

SIR,—I have the honor to submit herewith my twelfth annual report.

In my last report I suggested the advisability of making a change in my department. With the opening of the College year this change was put into effect, and my department has been relieved of the lectures in Agronomy. This arrangement, I am sure, will work to the best interests of the students, as it will place all lectures in those departments which are especially equipped for doing the work. In my own department, I still have all the work in Animal Husbandry, the Farm Superintendence, and the experiments in live stock, which is quite sufficient for one department.

During the month of January we held our Short Course in Stock Judging, and I am pleased to say that great interest was evidenced in this work. In addition to judging various breeds of stock alive, we conducted slaughter tests with cattle, sheep, and swine. This is perhaps one of the most important features of the course, and I believe it is bound to have an important influence in live stock education.

VISIT TO GREAT BRITAIN.

During the past summer, I paid a visit to Great Britain, under instructions from the Minister of Agriculture, mainly for the purposes of purchasing some stock for the College Farm. Most of the selections were made with the assistance of the Minister of Agriculture, and the stock purchased is as follows:

One Shorthorn heifer from J. Deane Willis, Bapton Manor, Wiltshire; two Hereford heifers from John Tudge, Craven Arms, Herefordshire; one yearling Aberdeen Angus bull, and one three-year-old cow with bull calf by her side from W. S. Ferguson, Pictstonhill, Perthshire, Scotland.

Five Border Leicester ewes and one ram from W. S. Ferguson; six Shropshire ewes and one ram from the flocks of Thomas A. Buttar, Coupar-Angus, Scotland, T. S. Minton, Montford Bridge, Salop, and Edward Nock, near Shrewsbury.

The animals, as a whole, are good representatives of the different breeds, and constitute an important acquisition to the College herds and flocks. I feel that the experience gained through this trip will be of great service to me in my College work.

INVESTIGATIONS REGARDING CANADIAN BACON ON THE BRITISH MARKET AND THE PRODUCTION OF BACON IN DENMARK.

While in Great Britain, I made it my business to make certain investigations regarding our bacon on the British market, and, as the Danes are our most formidable competitors, I was especially interested in comparing their product with our own. I also visited Denmark for the purpose of observing the methods of breeding and feeding swine in that country.

One of the most remarkable features of Danish bacon is its great uniformity of excellence, very few really bad sides of bacon being put upon the market. The Danish sides are characterized by a light shoulder, a light neck,

good length, and a large proportion of lean meat. In addition to this, the sides are well trimmed and placed upon the market in a very attractive form. On the other hand, when we come to examine Canadian bacon, we find some excellent sides, some only fair and some very bad indeed. The best Canadian sides possess excellent length and show great uniformity in the thickness of the layer of fat along the back; but, as a rule, they do not possess quite so much lean meat as the Danish sides. In length, however, the best Canadian sides are quite equal, if not superior, to the Danish product. The great fault of our bacon, however is its lack of uniformity. There are far too many short sides, thick shoulders, and heavy necks, which cause the Canadian product, as a whole, to show at a great disadvantage when compared with Danish. Just here a word to Canadian packers may not be out of place. Some of our packers need to take lessons in the art of making goods attractive, and I was extremely sorry to see many good sides of bacon so badly trimmed that their value was greatly lessened. From this it would seem that there is need of education among the packers as well as among the feeders and breeders of bacon hogs. As to the London commission merchants, they appear to have a very friendly sentiment towards Canada, and appear anxious to handle our bacon; but, of course, it must be of good quality before they can handle it to advantage. I was pleased to hear them speak in very high terms of our best bacon.

The study of the competition in the Smithfield market gives rise to several important questions in the mind of the person interested in this matter. Among these are the following:

1. How do the Danes maintain this uniformity in their product?
2. How do they produce such lean bacon?
3. To what extent can they increase their output?
4. Can we hope to compete successfully with them?

It was with these questions before me that I sailed in a Danish steamer from Harwich on the east coast of England, and landed in Esbjerg, on the west coast of Denmark, one fine morning in July. For a person not familiar with the Danish language, it is no easy matter to collect information, though one who knows what he wants can take in a good deal through his eyes in spite of the fact that his ears are of comparatively little use. However, through the aid of interpreters, I was able to pick up a few points here and there which are not without value.

The question regarding uniformity is very easily answered. One has only to look over the hogs of the country and the methods of marketing to understand very thoroughly how it comes that Danish sides of bacon resemble one another very closely. There are three classes of hogs in Denmark. First, there is what is called the "Danish hog". In color, bone, and general conformation of body it strongly resembles the Yorkshire, though perhaps the shoulder is nearer to that of the Tamworth. The neck is light, the jowl is also light, and the snout long and somewhat coarse, while the ears are large, thick, and drooping. It is claimed for this hog that it is more vigorous and an easier feeder than the Yorkshire. Next, we find the large Yorkshire, which is imported from England, bred pure at certain centres, and used for crossing on the native pigs. The breeders of Yorkshires agree with the government to keep nothing but pure bred Yorkshires on their farms, and in return for this they receive some financial aid from the government to help defray the expenses of importing. The third class is the market hog, or the cross between the Yorkshire and the Danish type. It is claimed that the cross-bred pigs made a better quality of bacon than either the pure Danish or Yorkshire, and the animals which I saw were certainly of a very desirable type. Of course, a certain number of pure Yorkshire and pure Danish hogs find their

way to market, but the great bulk of Danish bacon comes from the cross-breds as already described.

Another important point in connection with securing uniformity, is the method of marketing. The most important factories of the country are co-operative concerns. They are located comparatively close to one another and practically every farmer markets his own hogs. Each man's hogs are slaughtered separately, and after they are slaughtered they are graded, and he is paid for his hogs according to the quality of the bacon they produce. Of course, this means a great deal of work at the factory, but it seems that the results more than compensate for the extra labor. When we remember, therefore, that the Danes do not have the great variety of types of hogs that we have, and that strict account is kept of the quality of each farmer's hogs when he markets them, it is very easy to understand how they maintain such a high degree of excellence in their bacon.

The second question is not so easy to answer, though the foods used are, as a rule, conducive to producing a large proportion of lean meat. It will be remembered that Denmark is a butter-making country, and that practically every farmer who raises hogs also keeps cows and feeds the skim-milk to his hogs. There is, as a rule, a fixed relation between the number of hogs fed, and the number of cows kept. Because grain is dear, and because skim-milk is a by-product and consequently cheaper than almost any other food at the farmer's disposal, there is little encouragement for the farmer to feed more hogs than his supply of skim-milk would warrant. In addition to skim-milk, barley, is largely fed, though other grains are sometimes used, and in some districts corn is used to a considerable extent. The use of corn, however, is looked upon with disfavor by the packer, and I understand that less corn is fed at the present time than was fed a few years ago. It is quite probable that the breeding of the hogs, has something to do with the amount of lean meat, and the breeding, combined with the feeding of skim-milk probably constitute the answer to the second question. It is a noticeable fact, however, that the market hogs are allowed very little exercise. In fact, about the only hogs that are allowed any exercise worth speaking of are the breeding sows, which are given the run of small lots. Land is too valuable to allow of pasturing, and a hurried trip through the country might give one the impression that there was not a hog in it. Judging from Danish methods, therefore, we may conclude that it is possible to produce a first-class article of bacon without any considerable amount of exercise, a fact which is borne out by our own experiments.

The question regarding the possible increase in the output of Danish bacon is one which does not admit of a definite answer. One can judge merely by what he sees, and by certain indications in connection with this industry in Denmark. One thing which is very suggestive is the fact that there are a number of factories in Denmark at the present time which have been forced to close their doors, and others are running at a loss, not being able to obtain enough hogs to make their operations profitable. At the time of my visit, the farmers were receiving about six and a half cents per pound live weight for their hogs, and they were complaining very bitterly that the price was too low to admit of profit to the feeder. When the price declines to the neighborhood of six cents, the tendency is for the farmers to curtail their operations in feeding hogs, and the best authorities I could find, estimated the cost of producing bacon in Denmark to be six cents per pound live weight. Taking this fact in connection with the insufficiency of hogs to support all the factories, we would naturally infer that it is not likely the Danes will expand their output to any great extent. As stated before, there is a relation between the amount of skim-milk produced upon a farm and the number of hogs fattened. This fact

tends to act as a check upon the expansion of the business of producing bacon hogs; and as soon as the price declines, feeding operations are naturally curtailed, as previously stated. If it were not for the fact that Danish bacon sells for a higher price on the English market than our product, we would certainly be able to drive them out of the field. As it is, we have a very great advantage in being able to feed hogs very much cheaper than they can, and, therefore, we can undersell them on the British market and make a very fair profit. At the same time, there is great need of our watching very carefully the quality of our bacon, because it is much easier to lose a reputation than to gain one.

From what has been said in the previous paragraphs, it will be seen that we have a good fighting chance on the British market, provided we do not lose sight of the question of quality. Though it is true that the British commission merchants entertain a friendly sentiment towards Canadians, yet sentiment will not serve as a substitute for quality in the goods we send forward. When it comes to a matter of catering to the tastes of the public, sentiment is a very small factor in the enterprise. If the goods are not right, the consumer will look elsewhere, and, though he is ever so willing to purchase Canadian goods, he will not do so unless they are what he requires. We can undersell the Danes on the British market; but, at the same time, if we would only produce an article of equal merit, we would be able to obtain as high a price as they obtain at the present time, and this would mean a very large additional profit to us. Those who wilfully close their eyes to the importance of producing hogs of the right type and quality, are acting as a severe handicap upon our trade in Great Britain. They fail to see that, in the long run, they are the losers. There has been, it is true, a marked improvement in the quality of our bacon during the last few years; but much remains to be done before our product, on the whole, equals that of Denmark, and whether we hold our own in the British market depends for the greater part upon the farmers of this country. I believe that if we make up our minds to produce bacon equal to that of any other country, we can do so, and it remains to be seen whether the farmers of this country will rise equal to the occasion or not. An increase in the value of our bacon of 3 or 4 shillings per hundred weight would mean a very substantial profit to our farmers. It is quite possible for us to secure this additional price if we make up our minds to that effect, and it seems strange that so many farmers cannot look at this side of the question.

There still remains a great deal to be done in the way of spreading information among our farmers regarding this important industry.

Farm Superintendence.

The past summer was abnormally wet, especially during harvest. As a result, a number of our crops were seriously injured, and the yields are consequently not so good as we were led to expect by the promise earlier in the season. Following are a few notes on some of the principal crops grown during the year:

Meadow. We had ninety acres of hay which yielded about two and a half tons per acre. Our method of making hay is the same as described in last year's report. We still use the side delivery rake and hay loader. As stated in last year's report, we believe the saving in labor effected by these implements more than compensates for any slight superiority in the quality of the hay which might be obtained through the old method.

Oats. There were 85 acres in oats, 75 acres of which were of the Siberian variety, and 10 acres of Tartar King. The oats followed potatoes, corn, rape, and fall-plowed sod. During the preceding fall, the potato and corn ground

was gang-plowed lightly, harrowed thoroughly, and then ribbed up with double mould-board plows. In the spring the ribs were first harrowed, then cultivated, and harrowed again before sowing. The oats were sown with the drill at the rate of one and a half bushels per acre, along with which was sown a mixture of red clover, timothy, and alsike in the proportion of about seven pounds of red clover, three and a half pounds of timothy, and one and a half pounds of alsike. The rape ground was also plowed lightly in the fall and prepared for seeding in the spring by means of the harrow and spring tooth cultivator. Owing to the very wet season, our oats produced too great a growth of straw and lodged very badly, which interfered seriously with harvesting operations. The Tartar King oats did not stand up any better than the Siberian, and for our conditions, I doubt whether they are quite so satisfactory. The average yield, in spite of unfavorable conditions, will be close to 70 bushels per acre.

Barley. 30 acres of Mandscheuri barley were sown after roots and sod. The root ground was ribbed up in the fall with a double mould-board plow, and in the spring harrowed and cultivated across the ribs before sowing. For cultivation of sod see method of cultivation for roots. The barley was sown with the drill at the rate of one and one-half bushels per acre. It was sown May 3rd and harvesting commenced August 1st. The yield was about 50 bushels per acre.

Mangels. We grew 10 acres of the Yellow Intermediate variety. They were sown May 25th with the corn planter on the flat in drills 30 inches apart. The germination was good, and though the field is not first class as regards soil, part of it being very high and gravelly, the yield was nearly 900 bushels per acre.

The mangels followed sod which was plowed about four inches deep when opportunity occurred during the months of July and August. The ground was rolled and harrowed after plowing, and later was thoroughly cultivated with the spring tooth cultivator. Manure was applied on the surface during the winter at the rate of about 15 tons per acre. In the spring, the ground was gang-plowed, harrowed, rolled, and cultivated both ways with the King cultivator with narrow points which loosened the soil to a depth of six or eight inches. Subsequent harrowing and rolling prepared the ground for sowing.

Turnips. Owing to the very wet spring, the ground that we had intended for turnips was entirely unfit for the purpose, and was eventually sown with millet, which was cut for hay. The only turnips we grew was a small patch of about two acres on a part of the mangel and potato ground which was too wet at the time these crops were planted. They were sown very late, and consequently gave rather a small yield.

Corn. 30 acres, mostly Wisconsin Earliest White Dent, were planted with a check-row planter in hills 42 inches apart. In spite of the cold, wet season, we had a very fair crop, the 30 acres averaging about 15 tons per acre, though the corn was not so well matured as it should be to give the best quality of silage. The preparation of the soil was practically the same as for mangels.

Potatoes. Of this crop we had about 8 acres of the Empire State variety The seed potatoes were cut with at least two strong buds on each piece, and dusted with land plaster immediately after cutting. The crop was sprayed several times with Paris Green and Bordeaux mixture. In spite of precautions, however, the rot affected the crop very severely, and the yield was extremely unsatisfactory.

The potatoes followed sod, and the fall cultivation was the same as for mangels, with the exception that the manure was applied in the fall and the ground ribbed up with double mould-board plows after manuring. In the spring, the ribs were harrowed down and the ground gang-plowed and loosened with the King cultivator as in the case of mangels. Before planting, furrows were opened up with double mould-board plow 30 inches apart, and the potatoes were planted 12 inches apart in the rows. The drills were then split so as to cover the potatoes. In planting, care was taken to cover the potatoes as soon as possible after they were planted. In going across the field in one direction, the plow opened up a new furrow; but in coming back it covered the potatoes that had been already planted. Thus the potatoes were exposed for a very short time to the sun. After the ground had settled, it was harrowed first lengthwise of the ribs, and a little later cross-wise, so that by the time the plants appeared the ground was practically level. In addition to making the ground level, the harrow checked the growth of weeds and prevented the formation of a crust on the soil. The ground was also harrowed after the plants were showing above the surface. Subsequent tillage was with the horse-hoe, or scuffler. The last time the scuffler was sent through the potatoes, a little earth was thrown towards the vines by means of small mould-boards. In the case of a large crop, this tends to prevent the tubers from becoming exposed to the sun.

Notes on Feeding Stock.

As stated in previous reports, our methods of feeding vary according to circumstances. Last winter, we fed no hay whatever to our cattle, except the calves and bulls. This winter we have followed the same plan up to the time of writing (the end of December), but intend to use a little hay mixed with the cut straw during the following months. Calves are fed clover hay and roots, with sometimes a small allowance of silage. They are also fed what they will eat readily of oats and bran, to which we commonly add a small allowance of oil-cake. The bulls also get hay and roots but, as a rule, they are fed no silage. They are also fed a light ration of oats and bran, which is varied in quantity to meet what we consider the requirements of the case. We like to keep our bulls in good condition, especially those of the beef breeds, and we aim to feed with that object in view. Our breeding cows, and the heifers, except calves, are fed a mixture of pulped roots, cut straw, and silage, which is usually mixed a day in advance of feeding. As has already been indicated, hay is usually added to this ration during part of the winter. Cows that are not milking do not receive any meal, unless in exceptional cases. Milking cows and growing stock receive a fairly liberal allowance of ground oats and bran. This winter we are feeding some twelve head of steers which we hope to market during April. They are fed the same mixture of silage, roots, straw, etc., as the cows, and, in addition, a ration of meal from mixed grains. At the present time, oats and barley are the main grains used, but this varies according to what is most readily available. We commenced feeding between four and five pounds of meal per day to each steer during the month of November. At the present time, they are receiving nearly six pounds each per day, and the quantity of meal will be increased probably to nine or ten pounds each per day before the end of the feeding period. The idea is to increase the meal as they become accustomed to it.

Our sheep are fed mainly clover hay and turnips, from 3 to 4 pounds of roots being allowed to each ewe during the earlier part of the winter. This quantity is usually slightly reduced a month before the lambing season. In the case of thin ewes, or when the hay is not of good quality, we usually feed

some oats and bran to our breeding ewes. Lambs are fed some oats and bran, and usually a little oil-cake. After the lambs arrive, the ewes are fed liberally upon roots, oats, and bran in addition to clover hay.

As regards the feeding and management of swine, I would refer readers to Bulletin 129, issued by the Department of Agriculture, Toronto. I might say, however, that we have now arranged matters so that we can manage our swine to better advantage than heretofore. Our breeding sows run in a small outside lot, and at the back of the lot we have placed a small house in which they sleep. This building is 8 feet wide, 16 feet long, 7 feet high in the front, and 3½ feet high at the rear. It has a floor, and the sides and roof are simply single boarded with battens over the cracks. The pen is set facing the south, and in this side is a window to admit light and sunshine, and a small opening near one corner large enough for the sows to go in and out. The opening is never closed, but the sows are given plenty of bedding, and are quite comfortable in the coldest weather. We have had as many as ten sows sleeping in this pen at one time. The sows, being fed at the opposite side of the lot, are compelled to take exercise in going backwards and forwards for their food, and we find this has a very beneficial effect.

We find that very young pigs do not thrive when in the pen along with large pigs, particularly during cold weather when it is difficult to secure thorough ventilation. We have therefore repaired the old piggery and arranged it for a farrowing pen, in which the sows are brought from the outside lot previous to farrowing, and in which the young pigs can be kept until they are at least several months old. The large piggery is used for the boars and pigs that are large enough to be kept in a large pen with other pigs without injury. When the sows are kept in as cold quarters as we are keeping ours, they require rather more meal, but we find that it is money well expended. Our principal meal ration for sows consists of ground oats and bran, with sometimes middlings or shorts mixed with it. In addition to this, we feed a fairly liberal amount of either roots or the refuse from the College kitchen. The same meal ration is used at all times for our breeding sows, and we find that the mixture of oats and bran is about as satisfactory food as we can use when a sow is nursing her pigs.

We have never found anything more satisfactory than skim-milk and middlings for young pigs after they are weaned, though I believe a few oats mixed with this ration is rather an advantage. When skim-milk is not available, the middlings are better scalded, and allowed to steep for several hours before feeding. We have never been able, however, to secure as good results when skim milk was not available. As the pigs become older, we usually introduce a little ground barley into their ration, and the proportion of barley is usually increased until it is at least half of the total ration fed. All our hogs are fed either roots or kitchen refuse in addition to the meal ration, as we find a variety of food of this kind, especially the addition of a bulky food, is beneficial to the digestive organs.

During the summer, our sows are pastured in a small lot adjacent to the buildings, though we have found difficulty in securing crops that would give pasture early in the spring. This fall we have sown some hairy vetches in the hope that they may give spring pasture, though I fear they may be winter-killed, as they did not make a very strong growth during the fall. Rye might be used with fairly good advantage for this purpose. For later pasture, we use rape, which we sow as early as possible in the spring, and we usually sow a second patch of rape for later pasture. Our aim is to make the sows take as much outdoor exercise as possible. We have not succeeded particularly well, however, in pasturing very young pigs, though we usually aim to give them exercise in paddocks adjoining the buildings.

Live Stock Experiments.

We are still continuing our work with long-keep and short-keep steers, and with different methods of feeding swine. A full account of this work will be found in the report of the Lecturer in Animal Husbandry, who has assisted me in carrying it out. I regret to say that, owing to the necessity of changing experimental feeders twice during the past winter, our results with steers are very unsatisfactory. We have now obtained the service of an efficient feeder, and in future we hope to get better results, provided we are fortunate enough to be able to retain his services. Owing to the unsatisfactory nature of our results with steers, we have decided not to publish them this year, but to hold them over for comparison with next year's results.

Outside Work.

During the past year, we have as usual had many calls upon our department for assistance in different parts of the Province. I believe it is good policy to comply with these requests as far as possible, because it tends to keep us in touch with the requirements of the farmers throughout the country, and also brings farmers into sympathy with the work of the College.

I have the honor to be,

Your obedient servant,

G. E. DAY.

PART X.

THE LECTURER IN ANIMAL HUSBANDRY.

To the President of the Ontario Agricultural College:

SIR,—I beg herewith to submit a brief report of my third year's work as Lecturer in Animal Husbandry.

The scope of my work has been defined in previous reports and consists, primarily, in giving instructions to students in Animal Husbandry, and also in taking charge, under the supervision of the Professor of Animal Husbandry, of the experimental feeding work. During the past summer, in the absence of the Farm Superintendent, Prof. Day, my duties were somewhat increased by my attention to matters relating to the Farm Superintendence.

The instruction work in Animal Husbandry I have endeavored to make as practical as possible, in doing which I have presumed greatly upon the generosity of numerous farmers and stock breeders in Toronto, Brampton, Hamilton, Alma, Salem, and a large number within a convenient radius of Guelph, to whose places I have taken the students, in order to bring them in personal contact with our leading stockmen and farmers, and especially that they might learn the judging, feeding, and management of the various classes of stock by personal observation on the farms and in the stables of these men. To those farmers and stockmen, who have so willingly given their time and allowed the use of their stock, I here take the opportunity of expressing our heartiest appreciation for their liberality and readiness in helping on this very important work.

During the year I have attended and taken part in several institute meetings, and have acted as judge of various classes of live stock at Toronto and a large number of smaller exhibitions.

EXPERIMENTS WITH SWINE.

BLOOD MEAL AND TANKAGE AS COMPARED WITH SKIM-MILK FOR HOGS.

In last year's report, an account was given of a series of experiments conducted to determine the value of Blood Meal and Tankage as supplementary foods to an ordinary meal ration for hogs. These foods are by-products from the slaughter houses, but, as yet, are not manufactured by our Canadian firms in a sufficiently palatable form to be used as foods for animals. At present, blood-meal and tankage made in Canada are being sold to firms across the line to be used as fertilizers. The importance of retaining and feeding these by-products on our own farms, rather than allowing them to go out of our country, is apparent to any one who realizes the importance of maintaining and increasing the fertility of our Canadian farms.

The tankage and blood-meal used in this experiment were supplied by Swift & Co., of Chicago, and, although supplied free by that firm on account of being used for experimental purposes, would have cost us for blood meal $55 per ton and for tankage $33 per ton. No doubt Canadian firms could supply these foods at a cheaper rate, but the calculations in the table below are made upon a basis of the above prices.

In this experiment there were eight groups of pigs,—four in each group, averaging in weight from 21 to 40 pounds. All were fed the same meal ration, consisting, at first, of pure middlings, but with a gradually increasing amount of barley and some oats, until at the last the ration consisted of about

three parts barley, one part oats, and one part middlings. In addition, supplementary foods were added to nearly all the groups. The following table shows the ration for each group.

Group 1.	Blood Meal and Meal.	Proportion	1:9.
" 2.	" " " "	"	1:14.
" 3.	Tankage and Meal.	"	1:9.
" 4.	" " "	"	1:15.
" 5.	Skim-milk and meal.	"	2:1.
" 6.	Meal alone.	"	
" 7.	Blood Meal, milk and meal.		1:15:15
" 8.	Tankage " " "		1:15:13.

The experiment was commenced on June 27th, and completed on November 23rd. This was rather a longer feeding period than last year's due in part to the character of the pigs themselves, but also because they were not fed quite as heavily as those of the previous year. It is a significant fact that the slightly lighter feeding, although it did require a longer period, proved somewhat more economical of grain and other foods.

The blood meal or tankage or milk were mixed with the regular meal ration and moistened to a thick paste. The pigs were fed just about as much as they would eat up clean twice each day. Water *ad libitum* was supplied in the troughs afterwards. In addition, the pigs were fed at noon a very small armful per pen of grass or clover, or green oats or rape or soy beans and latterly roots, all of which were conveniently near the piggery. In the statement, made below, no account is taken of this but, at the same time, we have found that even a very little green food fed regularly, as above described, is a most beneficial food for pigs.

The table presented below gives the gains, the food consumed, and the cost of producing the gains. In estimating the latter, meal is valued at $18 per ton, blood-meal at $55 per ton, tankage at $33 per ton, and skim-milk at 10 cents per hundred.

Group.	Gain.	Food consumed.	Food consumed for 100 lbs. gain.	Cost of 100 lbs. gain.
1. Blood Meal and Meal, heavy blood meal ration.	501 lbs.	Meal 1,757 lbs.; blood meal 194 lbs	Meal 351 lbs.; blood meal 39 lbs	$4.23
2. Blood Meal and Meal, light blood meal ration..	461 lbs.	Meal 1,710 lbs.; blood meal 123 lbs	Meal 371 lbs.; blood meal 27 lbs	4.08
3. Tankage and Meal, heavy tankage ration	501 lbs.	Meal 1,851 lbs.; tankage 199 lbs	Meal 369 lbs.; tankage 40 lbs	3.98
. Tankage and Meal, light tankage ration	498 lbs.	Meal 1,720 lbs.; tankage 144 lbs	Meal 345 lbs.; tankage 23 lbs	3.48
5. Skim-milk and meal	568 lbs.	Meal 1,888 lbs.; milk 3,236 lbs	Meal 332 lbs.; milk 639 lbs.	3.63
6. Meal alone	481 lbs.	Meal 1,980 lbs	Meal 412 lbs	3.70
7. Blood Meal, Milk and Meal	562 lbs.	Meal 1,862 lbs.; blood meal 120 lbs.; milk 1,871 lbs	Meal 330 lbs.; blood meal 22 lbs.; skim-milk 333 lbs	3.92
8. Tankage, Meal and Milk.	597 lbs.	Meal 1,744 lbs.; tankage 126 lbs.; skim-milk 1,942 lbs	Meal 293 lbs.; Tankage 21 lbs.; skim-milk 325 lbs ..	3.66

Notes on Above Table.

1. In comparison with last year's experiment, the results are not so much in favor of blood-meal and tankage; but, summarizing all the conditions, we

consider the figures quoted in this table represent about rightly the comparative value of these supplemental foods.

2. The pigs fed on meal alone made very satisfactory but not as large gains as those in the other groups, and had they been finished to the same degree, for example, as groups 7 and 8, would have cost considerably higher than the figures stated here.

3. Allowing for rate as well as for cost of gain, the groups of pigs are rated as follows: Group 5 receiving skim-milk and meal, and group 8 receiving tankage, skim-milk and meal, best and about equal; next in order are group 7, group 4, group 6, group 3, group 2, group 1.

4. By reference to the table it will be seen that blood meal, mainly on account of its extra cost, proved the least satisfactory of these supplemental foods. Tankage proved much more satisfactory and, while not quite equal to skim-milk, yet, when fed in small quantities along with a small quantity of skim-milk, gave about the best results.

5. Judging from this, we would say that tankage would prove itself an excellent food to add to a ration for pigs when only a limited amount of skim-milk was available, which is often the case on the average farm.

6. In both cases where tankage and blood-meal were fed in different proportions, the smaller proportion proved more satisfactory. This is about what we would expect in considering the nature of the main meal ration, viz., middlings, barley, and oats. Had the ration consisted of a large amount of corn, it is very likely that the larger amount of these by-products would have proved more satisfactory.

7. Averaging up these results by comparing the gains and rate of gain made when meal alone was fed with those made when supplemental foods were fed, we may, roughly, indicate the figures a farmer could afford to pay for these foods, for the purpose of pig feeding: Skim-milk 15 cents per hundred; Blood-meal $30 per ton, and tankage $30 per ton.

Pigs on Pasture.

During the same period that the above pigs were fed inside, we fed pigs outside in order to compare the economy of pasture feeding with that of pen feeding. Those who have kept in touch with our former experiments in the pasture feeding of pigs, will remember that we have invariably reported this method to have cost us more than pen feeding. Hence, this year, we selected the 24 growthiest pigs of the lot to be turned out on pasture in order to see just how favorable results we could get.

The pigs were divided into two groups of 12 each. Lot one received as a meal ration just what they would eat up clean. Lot two received about two-thirds as much meal as lot one and, so, had to depend somewhat more on pasture for sustenance although, it must be added, that they did not seem to eat much more green feed than the heavy-feed lot.

The crops used for pasturing were, first, clover and, latterly, rape. In order to economize the pasture as much as possible, we hurdled off only a small part of a field at first, and gradually moved the hurdles back so that the pigs had fresh pasturage about every week. The pigs found shelter in movable houses.

The pigs were turned out on June 22nd, at which time they averaged in weight about 50 pounds. They ran for five weeks on clover and for other ten weeks, on rape. In all, the pigs used about an acre of pasturage. On October 7th they were brought inside and fed for seven weeks more, receiving during this period roots to take the place of the succulent pasture food. During the latter period, both groups received all the meal they would eat.

The following table shows the gains, and pounds of meal consumed up to the end of the time the pigs were on pasture, and the total gains and total meal consumed and the cost of this from beginning to end of experiment. In estimating this cost, meal is charged at $18 per ton and no account is taken of the cost of pasturage; but this is discussed in Note 2 below.

Group.	Gain June 22—Oct. 7.	Meal consumed.	Meal for 100 lbs. gain.	Total gain June 22—Nov. 23.	Total Meal.	Meal for 100 lbs. gain.	Cost of Meal for 100 lbs. gain.
Heavy feed.	928 lbs.	3,907 lbs.	421 lbs.	1,334 lbs.	6,919 lbs.	517 lbs.	$4.65
Light feed..	861 lbs.	3,041 lbs.	353 lbs.	1,339 lbs.	5,969 lbs.	445 lbs.	$4.00

Notes.

1. It cost more to finish these pigs than the ones in the former experiment.
2. The pasturage and roots allowed the whole 24 pigs was worth about $20, and, if this were taken into consideration, the cost of 100 lbs. gain would have been increased about 60 cents in each case.
3. As compared with this, the green feed given to the pigs inside did not cost more than one-third as much, so that, had this item been taken into the calculation, the results would have been still more in favor of the inside pigs.
4. In former years, the results have been even more decidedly in favor of inside pigs, but, as stated above, we made every effort, this year, to give the outside lot the best chance, and feel sure that at least, so far as young pigs are concerned, feeding inside, under the conditions prevailing at Guelph, is more economical than feeding outside.
5. In looking over the table, the reader will notice the increased amount of grain required for 100 lbs. gain during the last stage as compared with the former stage. This is an illustration of a principle well known to feeders of all kinds of stock, viz., that the cost of gain increases with the age of the animal.
6. The importance of carefully husbanding the grain fed to pigs on pasture is strongly emphasized in this experiment. At the time the pigs went inside, the light feed ones were considerably thinner than the heavy ones, but they had developed just as big frames and went ahead more rapidly during the last stages of feeding, at which time they, too, were fed a full ration.

Soy Beans *vs.* Rape as Green Feed for Pigs.

By way of variety in green feed, we grew a small plot of soy beans and, in order to determine their value, fed two groups of pigs of six each on the same meal and milk ration, but one lot Soy beans, and the other lot rape for green feed. The pigs averaged about 70 lbs. each at the beginning of the experiment August 18th, and were fed for 5 weeks, eating about four pounds each of Soy beans per day and about five and a half pounds each of rape per day. The following table shows the feed consumed and the gains made by each group:

Group.	Gain.	Feed consumed.
1. Fed Rape	145 lbs.	502 lbs. meal ; 1,004 lbs. milk ; 1,381 lbs. Rape.
2. Fed Soy Beans	159 lbs.	502 lbs. meal ; 1,004 lbs. milk ; 983 lbs. Soy Beans.

Notes.

1. It is evident that the Soy beans are a richer food than rape, a lesser quantity producing a greater gain.
2. On the other hand, Rape is a heavier yielder per acre than Soy beans, the yields of fresh cut forage in this case being: Rape 22 tons per acre and Soy beans 15 tons per acre.
3. From this it is evident that, for purposes of feeding green forage to pigs in pens, a given amount of land might be equally profitably sown with either Soy beans or rape.
4. When, however, it is desired to pasture pigs on one or the other crop, rape will stand the tramping, etc., much better, and is the more profitable crop.
5. We commenced feeding the Soy beans when they were in blossom, and they kept wonderfully green for about 5 weeks after this.
6. For particulars with regard to Soy beans see report of the Experimentalist.

Experiments in Steer Feeding.

During last winter we conducted experiments in feeding long-keep and short keep steers, and also conducted a test with steers fed loose as compared with those tied in stalls. Unfortunately, however, we were compelled to change feeders three times during the experiment, and, believing, that our results were prejudicially affected by this fact, we have decided not to publish them this year, but to hold them over for verification by future experiments.

Respectfully submitted,

M. CUMMING.

PART XI.

THE PROFESSOR OF HORTICULTURE.

To the President of the Ontario Agricultural College:

SIR,—I have the honor of presenting herewith my twentieth annual report on the work of the Horticultural Department. We have had a very busy year and are pleased to be able to report good progress. The work in this department is so varied that it is impracticable to treat of it in detail in a report of this kind. We will, therefore, merely mention some of the lines that have engaged our attention, and deal more fully with a few of those which may be of most interest to the public.

TEACHING.

At an educational institution of this kind, the instruction of students naturally must receive first consideration, and with this work we have been engaged most of the time for eight or nine months of the year. A full course of instruction in Horticulture, as outlined in the College Circular, has been given to the students of the first, second, and fourth years. The course embraces lectures, laboratory, and practical work in fruit growing, vegetable gardening, landscape gardening, and floriculture. We have been endeavoring year after year to make the course as thorough and practical as possible, and after fifteen years experience here, and from observations made at many of the leading Agricultural Colleges in the United States we feel confident that our students are getting as thorough and as practical a course in general horticulture as can be obtained anywhere on this continent. While this might seem like boasting, I do not take the credit to myself, for in class-room, greenhouse, lawn, garden, and orchard work I have had valuable assistance from others engaged in this department.

Our equipment in many respects is good, but we hope to make it still better. One important change made this year has been the building of a new and modern greenhouse on the site of the old conservatory. The display of plants and bloom in our conservatory has always been of great interest to thousands of our visitors, but has not been so valuable for the instruction of students as it might have been. The new building will be used primarily for the instruction of students during the winter months, and as far as practicable will be stocked with plants which will make an instructive display for the benefit of visitors in the summer.

The new house is 66 feet long by 26 feet wide and 18 feet high at the ridge, being three times as large as our old horticultural laboratory. It will afford excellent accommodation for our classes, and will permit of more demonstration work than was before possible. The old laboratory will be used as a plant house. The accompanying illustration is from a photograph taken last winter, when it was in use by about 100 of the students for practice in propagation and plant breeding.

CLASSES WITH MACDONALD INSTITUTE STUDENTS.

The Macdonald Institute, as a new department of the College, with its large classes of lady students and teachers in training for improvement of rural schools, in this and the Eastern Provinces, has brought us many new students interested in special lines of horticultural work.

These students require special classes and different courses of instruction from our regular full course students. Some of them are interested more particularly in school garden work and methods of practical instruction in agriculture and horticulture. Others are especially interested in floriculture and landscape gardening—the ornamental rather than the commercial branches of horticulture.

Some of the ladies took the regular long course in vegetable gardening with our Second Year students, and a special course in greenhouse work throughout the spring term.

To another class we gave a course of ten lectures with demonstrations and practical work, dealing especially with home floriculture and the small fruit and vegetable garden.

During the year we had two large classes of teachers in training, to whom was given a short course of lectures dealing with school garden work, and practical demonstrations in the laying out and planting of school gardens.

All of these are new courses instituted this year, and we expect to see them greatly improved and extended next year.

Correspondence.

The number of questions sent in by correspondents all over the country is increasing year by year. Over a thousand letters have been received and answered during the year. To answer all of these carefully requires a great deal of time and often considerable research, but it is doubtful if more valuable assistance can be given in any other way. Many of these questions and answers which were of general interest to the public as well as to the questioner, have been published in the *Canadian Horticulturist* and the *Farmers' Advocate*. We are pleased at all times to render assistance of this kind and will be glad to do so in the future as time and space will permit.

Meetings Attended.

During the year I attended and took part in the following public meetings:—

A series of orchard meetings near Ingersoll, and gave a talk on Cultivation and Cover Crops for the Orchard.

The Toronto Horticultural Society, and gave an address on Beautifying Home Grounds.

Five meetings of the Guelph Horticultural Society, and addresses on various Horticultural topics.

Commencement exercises in the Guelph Central school on the occasion of the awarding of prizes to the school children in an aster growing competition.

St. Joseph Island Farmers' Institute picnic at Richard's Landing and gave an address on the Work of the Algoma Fruit Experiment Station.

Canadian National Exhibition at Toronto, and gave an address on the care and Management of Orchards.

The Canadian Forestry Association, at Toronto, and gave an address on "Some Ontario Forest Problems."

Ontario Fruit Growers' Association meeting at Toronto, and gave an address on the Planting of Home and School Grounds, also a Report on New and Seeding Fruits of the year.

The Guelph Winter Dairy School, and gave a lecture on the Cultivation of Small Fruits in Connection with Dairying.

The Short Course in Stock and Grain Judging, and gave a lecture on Improving the Appearance of Rural Homes.

The Ontario Agricultural and Experimental Union meeting at Guelph, and gave report on the Co-operative Testing of Small Fruits.

The Norfolk Union Fair at Simcoe, and judged the display of fruits; and gave suggestions for improvement of horticultural exhibit.

The Central Exhibition at Guelph, and judged the display of fruits.

This department also made a large educational exhibit at the Provincial Fruit, Flower, and Honey Show of diseases and insects affecting fruits and garden crops, and gave directions for combatting the same; also exhibit of methods and tools for grafting, protecting trees from girdling, etc.

Reports and Articles Published.

For the Fruit Experiment Station Report. A report on my annual inspection of the stations.

For the Ontario Fruit Growers' Report. A report on Some of the Promising New and Seedling Fruits of the Year, also an illustrated article on the Planting of Home and School Grounds.

For the Experimental Union Report. An account of our work in the Co-operative Testing of Small Fruits throughout the Province.

For the Report of the Canadian Forestry Association, an article on "Some Ontario Fruit Problems."

For the *Weekly Sun*, an article on "The Necessity for Adopting the Co-operative Plan of Packing and Handling Fruits."

For the local newspapers of the Province, a press bulletin "on The Growing of Rhubarb in the Cellar in Winter."

For the *Canadian Horticulturist* and *Farmers' Advocate*, numerous short articles on various subjects is answer to the questions of correspondents.

In conjunction with Prof. Reynolds, a bulletin now in press, dealing with the trial shipment of two cars of fruit from St. Catharines and Grimsby to Winnipeg.

Inspection of Fruit Experiment Stations.

At various times during the summer, as I could conveniently get away from the College I have visited each of the thirteen fruit experiment stations located in different parts of the Province. These stations are engaged in a work of inestimable value to the farmers and fruit growers of this country, and we would advise a careful perusal of the experiment station Report by all interested in fruit growing. A full account is given this year of the way in which the various classes of fruits stood the severity of last winter; and carefully revised lists are given of the varieties of fruits best suited for the different sections of the Province.

Co-Operative Testing of Small Fruits.

Eleven years ago we began in a small way the co-operative testing of strawberries, raspberries, and currants. Sixty experimenters then took part in this work. Year by year the work has been extended; new classes of fruits have been added, and we are now testing in this way the leading varieties of all of the small fruits commonly cultivated in this country, and

have on our books the names of about 1,500 persons who have taken up this work.

The varieties selected for distribution are those which have been found by repeated tests here and also at our Fruit Experiment Stations to be among the best.

The following is the list of plants offered for testing last spring:—

I. Strawberries: Clyde, Tennessee, Irene, and Van Deman—12 plants of each.

II. Raspberries: Cuthbert, Golden Queen, Marlboro', and Columbian—6 plants of each.

III. Black Raspberries: Gregg, Kansas, Palmer, and Older—6 plants of each.

IV. Blackberries: Agawam, Gainor, Kittatinny, and Snyder—6 plants of each.

V. Currants: Fay, Raby Castle, Victoria, and White Grape—2 plants of each.

VI. Black Currants: Champion, Lees, Naples, and Black Victoria—2 plants of each.

VII. Gooseberries: Downing Pearl, Red Jacket, and Whitesmith—2 plants of each.

Anyone wishing to join in the work next spring may do so by making application to the Horticultural Department, Ontario Agricultural College, Guelph, and a circular will be sent stating terms upon which the plants are sent out.

Trial Shipment of Fruit to Winnipeg.

Last September a trial shipment was made to Winnipeg of two car loads of tender Ontario fruits from St. Catharines and Grimsby. This shipment was planned by Prof. Reynolds of the department of Physics, and carried out with assistance from me, primarily with the object of finding out how such fruits could be carried to the North-west in refrigerator cars. Incidentally a number of other matters in connection with the handling of fruit have been brought to notice which are quite as important to the fruit trade at present as the question of transportation. Among these are the degree of maturity at which the various fruits should be picked for distant shipment; the size and style of package best suited for the various classes of fruits; and, above all, the need of greater uniformity in grading, packing, and branding of fruit for market. Fuller particulars on these points are given in a bulletin now in press.

Orchard Cover Crops.

For the past two years we have been conducting an experiment in our orchard with various kinds of cover crops. Both seasons have been moist and favorable for the growth of these late sown crops, and, on the whole, they have done remarkably well. Notes were taken late in the fall, both this year and last, on the growth and stand of each crop at the end of the season, and also last spring on the appearance of the previous season's crop

after passing the winter. We hope to continue this work until we have definite knowledge regarding the most satisfactory kinds of crops for this purpose, and next year we would like to have assistance from the Chemical Department in order to ascertain the effect of the various crops upon the chemical composition of the soil.

Notes on Condition of 1903 Crops in Spring of 1904.

The following notes on these crops are given by H. S. Peart, B.S.A., Demonstrator in this Department, who carried out the details of the experiment:

On July 31st and August 1st, 1903, a number of cover crops were sown in the College orchard. The fall growth of these was reported on last year. The following notes taken on May 7th, 1904, will give some idea of the relative merits of the various crops and their powers of withstanding the winter and continuing growth in the spring:—

No. 1. *Red Clover*, sown at the rate of 15 pounds per acre, wintered very well and produced a mat about 3 inches thick to plow under in the spring.

No. 2. *Mammoth Clover*, sown at the same rate as red clover in No. 1, was practically equal to it this spring.

No. 3. *Crimson Clover*, sown at the rate of 20 pounds per acre, made a fair cover in the fall, but was nearly all dead in the spring.

No. 4. *Hairy Vetch*, sown at the rate of 40 pounds per acre made a dense mat in the autumn and in the spring was fresh and green with about 5 inches of growth on May 7th. An excellent cover, but the seeding was evidently heavier than necessary.

No. 5. *Alfalfa*, sown at the rate of 30 pounds per acre, came through the winter in first-class condition, standing about 6 inches high and very even.

No. 6. *Rye*, sown at the rate of 1½ bushels per acre, grew to a length of about 20 inches in the fall. It formed a good cover, but about twenty-five per cent. killed out during the winter, leaving the stand rather uneven.

No. 7. *Rape*, sown at the rate of 10 pounds per acre. Made a rank growth in the autumn, standing nearly two feet high on the ground, but was nearly all killed during the winter.

No. 8. *Hairy Vetch*, 40 pounds and Rye 30 pounds per acre. Both crops wintered well, the vetch being about 3 inches and the rye 8 inches high. These crops do better separately than when mixed, as the rye smothers to some extent the lower growing vetch.

No. 9. *Hairy Vetch*, 20 pounds and Cow Horn Turnips 12 ozs. per acre. The turnips were killed during the winter, and the vetch was too thin for a satisfactory cover.

No. 10. *Hairy Vetch*, 20 pounds, Crimson Clover 8 pounds, and Cow Horn Turnips 8½ ounces per acre. This mixture did not make a good cover in the fall, and in the spring both clover and turnips were dead, leaving the vetch too thin.

No. 11. *Hairy Vetch* 20 pounds and Crimson Clover 8 pounds per acre. The clover killed out; the vetch formed only about two-thirds enough top for a good cover.

No. 12. *Hairy Vetch* 20 pounds and Red Clover 8 pounds per acre. Both crops wintered well, but the cover was very much too thin.

No. 13. *Hairy Vetch* 20 pounds and Mammoth Clover 8 pounds per acre. Very similar to No. 12.

No. 14. *Rye* 1 bushel and Rape 4 pounds per acre. The rape nearly all killed out and the rye, owing to having been smothered by the rape in the fall, was very poor. Practically no winter cover.

No. 15. *Alfalfa* 15 pounds and Red Clover 8 pounds per acre. A good cover, the alfalfa being 6 inches and the clover 3 inches high and quite thick in the spring.

No. 16. *Alfalfa* 15 pounds and Mammoth Clover 8 pounds per acre. A good cover, similar to No. 15. About the centre of this plot was a patch of chickweed which killed out all the other plants but formed a very heavy and desirable cover in itself.

No. 17. *Alfalfa* 15 pounds and Crimson Clover 8 pounds per acre. The Crimson clover all died in the winter and left the alfalfa too thin for a good cover.

From the above notes it will be seen that Hairy Vetch, Red and Mammoth Clover, and Alfalfa all made good leguminous covers and that Crimson Clover did not stand over winter. Among the non-leguminous crops rye was superior to either rape or turnips.

Notes on Cover Crops in the Autumn of 1904.

During the past summer a number of the most desirable cover crops, tried last year along with a few new ones, were sown on July 20th and 21st. The ground was in fine condition, having been cultivated regularly during the early summer. A brief account of their relative growth as recorded on October 6th and again on October 26th is here given:—

No. 1. *Red Clover*, sown at the rate of 20 pounds per acre, made an even thick stand about 4 inches high.

No. 2. *Mammoth Clover*, sown at the rate of 20 pounds per acre, made growth very similar to No. 1. There is apparently little difference between the common and mammoth clovers at the end of three months' growth.

No. 3. *Crimson Clover*, sown at the rate of one-half bushel per acre. Made a rather uneven stand about 3 inches high, not as thick as No. 1 or No. 2.

No. 4. *Hairy Vetch*, sown at the rate of 35 pounds per acre. This made a fairly good cover lying very close to the ground, being only two inches high. It was somewhat uneven.

No. 5. *Alfalfa*, sown at the rate of 30 pounds per acre, made a good even cover about 10 inches high.

No. 6. *Rye*, sown at the rate of 1½ bushels per acre, made only a fair mat about 3 inches thick. The outer leaves were badly rusted, hence the growth was not so vigorous as it might otherwise have been.

No. 7. *Rape*, sown at the rate of 8 pounds per acre, made a very vigorous growth about 2 feet high.

No. 8. *Hairy Vetch*, 20 pounds and Red Clover 10 pounds per acre, made a rather uneven covering, averaging about 3 inches high.

No. 9. *Hairy Vetch*, 20 pounds and Mammoth Clover 10 pounds per acre, made slightly better growth than No. 8.

No. 10. *Hairy Vetch*, 20 pounds and Crimson Clover 12 pounds per acre, made a growth very similar to No. 8.

No. 11. *Alfalfa*, 15 pounds and Red Clover 8 pounds per acre. This mixture did not do nearly so well as last year, the clover being almost completely smothered by the alfalfa, which made about 10 inches of growth.

No. 12. *Grass Peas*, sown at the rate of 2 bushels per acre, made a rank cover about 9 inches thick, but were killed by frost by October 25th.

No. 13. *Alfalfa*, 15 pounds and Crimson Clover 10 pounds per acre, made a growth very similar to No. 11.

No. 14. *Medium Green* Soy Beans, 50 pounds and Early Yellow Soy Beans 100 pounds per acre. The seed of the Early Yellow beans was very low in vitality and made a poor stand. This crop made a very poor cover, and was frozen by the first frost.

No. 15. *Crimson Clover*, 10 pounds, Horse Beans 25 pounds, and Prussian Blue Peas 25 pounds per acre. The peas grew rather strong, making about 15 inches of growth. The clover was small and weak. The beans germinated very poorly and produced but few plants. The crop did not make a very satisfactory cover this year.

The comparative value of these crops will be noted again in the spring of 1905 and reported on later.

So far as this experiment has gone, the most satisfactory cover crops have been Hairy Vetch at the rate of 35 pounds per acre; common red or mammoth clover at the rate of 15 pounds per acre; alfalfa at the rate of 30 pounds per acre; rye at the rate of 1½ bushels per acre; and rape at the rate of 8 pounds per acre.

Orchard Fruits.

Last winter was one of the severest on fruit trees that have been experienced in this Province for many years. Peaches, pears, plums, and cherries, have suffered the most, and in some sections of the Province the greater number of these trees have been killed out. Even old established apple trees which have been bearing for years suffered severely. As a rule the trees most injured were those which bore heavily the summer before, their vitality no doubt being lowered by excessive fruit bearing.

Our orchards at the College are far from being typical of the best orchards in the country in proximity to the great lakes, yet they represent what may be found in many of the northern and inland sections. At pruning time last spring it appeared doubtful if many of the trees would recover from their winter injuries. The wood was black and the sap soured. The records taken later on showed the real extent of the injury, and it is quite likely that many of those that lived through the summer will not survive another winter.

Apples. In our young apple orchard where the trees are only eight years planted, there was only 10 per cent. of the trees winter killed. The Baldwins were all killed. We had twenty dwarf apple trees on Paradise stock, ten varieties, two trees of each, one-half of which were winter killed, the loss evidently being due to the stock upon which they were worked. rather than to the variety.

Notwithstanding the severe winter there were fifty-two varieties, or nearly half of those in the orchard, which bore fruit this year. These are classified below according as they bore a heavy, medium, or light crop:—

Those which bore heavily were:—Ben Davis, Copper's Market, Gideon, Grime's Golden, Longfield, Wealthy, Wellington.

And the following crab apples:—General Grant, Hyslop, Martha, Montreal Beauty, Transcendant, and Whitney.

Those which bore a medium crop were:—Alexander, Babbit, Blenheim, Gano, Haas, Hare Pipka, Magog-Red-Streak, North-west Greening, Ontario, Shackelford, Tolman, Transparent, Trenton, and Wallbridge.

Those which bore a light crop were:—Astrachan, Beitigheimer, Canada Baldwin, Colvert, Fameuse, Fallawater, Golden Russet, Hubbardston, Hurlbert, Lawver, Maiden's Blush. McMahon, McIntosh, Pewaukee, Peter,

Ribston, Rome Beauty, Salome, Scott's Winter, Seek-no-further, St. Lawrence, Tetofsky, Utter, Wagener, and Wolf River.

Plums. Nearly 20 per cent. of our plum trees were winter killed, and many of those that survived are severely injured. The Japan varieties came through quite as well as the European kinds, but there was no fruit on any of the varieties in 1904.

Pears. Over 35 per cent. of the standard pear trees were killed, and probably not half of those left will ever fully recover from the injury sustained. None of the survivors bore this year. Twenty dwarf trees on quince roots were all killed.

Cherries. About 44 per cent. of the cherries were killed, and nearly all of the sweet varities were cleared out. The fruit buds on those left, even of the sour varieties, were destroyed.

Peaches and Quinces. Twenty peach and twenty quince trees which had survived several winters were all killed out last winter.

Our experimental orchard, with the exception of the apple trees, was rather a discouraging sight this year, but we hope to profit by the experience gained and will replant with the more hardy kinds, and trust we may not in a long time have another such winter as the last.

The Bush Fruits.

Raspberries. Sixty varieties of raspberries have been under trial here for several years and careful records have been kept of their relative productiveness. Last year we observed that the plants in our whole plantation appeared to be losing vigor, so we decided to propagate new plants as quickly as possible and set out a new plantation. On taking up the plants last spring, we discovered the cause of the trouble in the form of large knotty swellings. These were identified by our College Biologist as raspberry root galls, caused by a slimy fungus known as *Dendrophagus globosus*. As this disease spreads rapidly and is without remedy, we were obliged to discard our own grown plants and dig and burn everything in the plantation. We have thus lost a collection of varieties that will take us some time to renew, but we succeeded in getting good plants from outside sources of a few of the old standard varieties, and the plants in the new plantation made good growth this year.

The varieties which have in the past given the best results are:—*Red:* Cuthbert, Marlboro', and Loudon.

Purple: Columbian.

Black: Older, Eureka, and Smith's Giant.

White: Golden Queen.

Currants. We have now an excellent experimental plantation of currants in which are forty-six varieties—twenty-one red, twenty-two black, and three white.

Among twenty red varieties which fruited this year, the four at the head of the list for a total yield are Red Cross, Red Crape, Fay, and Victoria. The Red Cross also headed the list last year. It is an excellent variety. The fruit is almost as large as that of Fay, and the bush is of a much better habit, being upright and vigorous.

The White Grape still holds the record for being not only the best white currant, but the heaviest yielding variety in our whole collection.

Among the twenty black currants which fruited this year, the four at the head of the list for weight of crop are: Naples, Saunders, Prince of Wales, and Champion. These are all good varieties, but for large fine fruit

we prefer Black Victoria, which stands eighth on the list this year, although it was first last year.

Gooseberries. Forty-five varieties of gooseberries are under test in our gooseberry plantation, twenty-eight of which fruited this year. The crop, however, was a poor one, and a report of the comparative yields this year would be misleading. The varieties which have for an average of the past eight years been the most satisfactory are: Pearl, Downing, Red Jacket, and Whitesmith. The last mentioned mildews some seasons, but has proved to be one of the most reliable English sorts.

Strawberries. For nine years past we have been conducting an extensive variety test with strawberries. During this time about 350 varieties have been grown in our trial plots, and every new variety of promise has been given a trial as soon as plants could be obtained. A number of the best varieties have been retained from the beginning which form a good standard for comparison of the new ones, while the poorer ones have been discarded after they have been given at least five years' trial.

The relative standing of the old varieties varies from year to year, depending upon the season and ability of the variety to adapt itself to the varying seasons. Taking the average of one season with another, the following have been found to be a few of the most desirable kinds to cover the season from early to late:

Early: Splendid, Wesley, and Van Deman.

Midseason: Warfield, Clyde, Haverland, Williams, Tennessee, and Ruby.

Late: Irene, Buster, and Saunders.

From the above we would select Splendid, Clyde, Warfield, and Irene as four of the best for a home or market collection. The first two are perfect flowering varieties, and the last two are imperfect. Clyde is large, only moderately firm, and rather light in color. The other three are medium size, firm, and good dark color, which makes them particularly desirable for canning.

Tomatoes.

For seven years we have been trying to carry on a variety test with tomatoes, and have had in our trial plots fifty varieties. The past three seasons, however, have been so cool and moist that the crop has not ripened satisfactorily. Last summer was one of the coolest on record for many years, and on our heavy cold soil even the earliest varieties, which usually give a good crop, failed to ripen more than a few fruits. We cannot do better, therefore, than mention those varieties which have given the best results in our previous tests. These are: Earliana, Mayflower, Dominion Day, Atlantic Prize, and Earliest of All.

The Vegetable Garden.

To supply the needs of the College dining hall we have had six acres devoted to vegetable garden, and will now have to double that area to meet the additional requirements of the Macdonald Hall.

To meet such a demand for supplies summer and winter has required a good deal of planning and careful management, but it has made it impossible for us to conduct extensive variety tests of vegetables, as we would have liked. It has necessitated our growing on a large scale those varieties most likely to supply the demand made upon us. We are therefore as yet largely in the position of market gardeners, rather than as an experiment station, in regard to the growing and testing of vegetables. However, as we have

had many requests for information along this line, we have prepared the following list of what we consider the leading varieties of the various crops usually grown in a vegetable garden. To this is added brief cultural directions for each crop.

LEADING VARIEITES OF VEGETABLES FOR A HOME GARDEN, WITH NOTES ON CULTIVATION.

ASPARAGUS. Conover's Colossal and Palmetto. Plant in rows 4 feet apart and 2 feet apart in the rows; apply manure liberally and cultivate thoroughly.

BEANS. *Summer*—Golden Wax. *Autumn*—Burpee's Bush Lima. *Winter*—Navy. Sow when danger of spring frost is passed.

BEETS. *Globe*—Egyptian Turnip. *Long*—Long Smooth Blood. Sow as soon as ground is fit to work. Thin when small to three inches apart and take out every other one as soon as they are large enough to use.

CARROTS. Chantenay and Scarlet Nantes. Sow early and thin the same as beets.

CABBAGE. *Early*—Winningstadt. *Late*—Flat Dutch and Savoy. *Red*—Mammoth Rock. Sow seed of early variety in hot bed about middle of March, and transplant to open ground about end of April. Sow seed of late varieties in the open ground about end of May, and transplant about first of July.

CAULIFLOWER. Extra Early Erfurt and Early Snowball. Treat the same as cabbage.

CELERY. *Early*—White Plume. *Medium*—Paris Golden Yellow. *Late*—Giant Pascal. Sow seed in seed box or hot bed about first of May. Prick out into flats or cold frame, when about an inch high, and transplant into trenches 4 or 5 feet apart about first of July.

CORN. *Early*—Golden Bantam and White Cory. *Medium*—Metropolitan. *Late*—Country Gentleman, and Stowell's Evergreen. Sow about first of May and if plants are injured by cold or frost sow again about 24th of May.

CITRON. Colorado Preserving. Sow in hills about 8 feet apart when danger of frost is over.

CUCUMBER. White Spine, for slicing. Cool and Crisp for pickling and slicing. Sow in hills about 4 feet apart when danger of frost is over.

EGG PLANT. New York Improved. Sow seed in seed box or hot bed about middle of April, and transplant in the open when danger of frost is past.

KOHL RABI. Early Purple Vienna. Sow seed early for summer use and again about middle of June for winter use.

LETTUCE. Hanson and California Cream Butter. Sow seed as early as possible, and at intervals of a month for succession. Thin plants to 6 or 8 inches apart for good heads.

MUSKMELLON. Rocky Ford or Emerald Gem and Montreal Market. Sow seed in well prepared hills when danger of frost is past.

ONIONS. Yellow Danvers, Prizetaker, and Red Wethersfield. Sow seed as early as possible. The thinnings may be used as green onions.

PARSNIPS. Hollow Crown. Sow as early as possible and thin to six inches apart in row. Leave part of the crop in the ground over winter for spring use.

PEAS. *Early*—Steele, Brigg's Extra Early. *Medium*—Gradus. *Late*—Champion of England. Sow early kinds as early as possible and others a couple of weeks later.

Potatoes. *Early*—Early Ohio. *Late*—Empire State. Keep potatoes for early planting in a warm room in the light for three weeks before planting. Plant a few for early use as soon as ground is fit to work, and follow with others when danger of frost is past. Plant late varieties about 24th of May.

Pumpkin. Sugar. Plant when danger of frost is past.

Radishes. *Early*—Rosy Gem and French Breakfast. *Winter*—Scarlet China. Sow early varieties as early as possible, and at intervals of two weeks for succession. Sow winter varieties in summer after crop of early peas.

Rhubarb. Victoria, or any other carefully selected seedling variety. Plant 4 feet apart. Manure liberally, cultivate thoroughly, and break out seed stalks as they appear.

Salsify. Long White. Sow as early as possible, and thin to four inches apart in the row. Part of the crop may be left in the ground over winter for spring use.

Spinach. Victoria. Sow as early as possible, and at intervals of a month if succession is desired.

Squash. *Summer*—Crookneck and White bush scallop. *Winter*—Hubbard. Do not plant until danger of spring frost is over. Bush varieties require about 4 feet of space between hills. Hubbard should have at least 8 feet.

Tomatoes. Earliana, Dominion Day, and Mayflower. Sow seed in seed box or hot bed about the middle of April. Transplant in the open when danger of frost is past.

Turnips. Golden Ball and Hartley's Bronze Top. Sow early for summer use and about June 20th for winter use.

Vegetable Marrow. Long White Bush. Plant when danger of frost is past.

Watermelon. Hungarian Honey and Cole's Early. Plant when danger of frost is past in well prepared hills 8 feet apart.

Ornamental Shrubs.

Of late years there has been considerable inquiry from both town and country regarding the most desirable kinds of shrubs for lawn planting. The answer to such a question of course depends to some extent upon the locality for which the shrubs are desired, as there are a number of very desirable kinds which can be grown in the southern sections of the Province, but which would not do at all for the north or east.

We have had an excellent opportunity here on the College grounds for studying a large number of the more hardy kinds, and we are pretty safe in saying that what will do well here will do well over the greater part of the Province.

From careful observations made during the past ten years, we would select the following as thirteen of the best hardy ornamental shrubs, from among about 200 species and varieties which have been planted here at various times. The list is given in the order of their season of bloom and covers the season fairly well from the earliest bloom in the spring till frost destroys the last in the autumn.

1. *Forsythia suspensa.* Golden Bell. An open, spreading bush about six feet in diameter. Flowers large golden bells, an inch or more across, appear before the leaves, about the end of April, and last about three weeks; very showy.

2. *Ribes aureum*. Golden Currant. A very hardy vigorous growing bush about six or eight feet in diameter. Flowers golden yellow, very abundant, and having a delightful spicy fragrance. In bloom May 9th and lasts two weeks.

3. *Pyrus japonica*. Japan Quince. A showy bush six or eight feet in height, with glossy green foliage. Half hardy when young, but after a time becomes acclimatized and quite hardy. Flowers large and brilliant scarlet, some varieties pink and white. In bloom about May 15th and lasts nearly three weeks.

4. *Caragana frutescens*. Siberian Pea Tree. A very hardy showy little bush about five or six feet in diameter. Has a luxuriance of fine green foliage, which appears early and is followed about May 24th with an abundance of clusters of pea-shaped yellow flowers. Bloom lasts a little over a week.

Fig. 1. Horticultural Laboratory. Students at work in plant propagation.

5. *Syringa vulgaris*. Lilacs in variety. The common lilac is so well-known as not to need description and is appreciated by all who grow it. There are now a great many improved varieties, with single and double flowers, varying in color from white and pink to dark purple. In bloom about May 24th and lasts for two weeks or more. Some of the Chinese and Japanese species are very desirable and extend the season of bloom to July 1st.

6. *Pyrus angustifolia*. Bechtel's Double-flowered American Crab. This is a crab apple tree of medium size, and very hardy. Four years after planting it began to bloom and bears large, double pink flowers, an inch and a half in diameter. At a distance they look like small roses and are very fragrant. In bloom about June 1st and lasts about two weeks. These handsome flowers make such dainty buttonhole bouquets that on public grounds, such as ours, the tree becomes the prey of vandal bouquet lovers.

7. *Spiraea Van Houtei*, Van Houtte's Spiraea. This is one of the best of the spiraeas. It makes a graceful, symmetrical little bush, about five feet in diameter, with slender drooping twigs. The bloom is pure white, very profuse, appears the first week in June and lasts about two weeks.

Fig 2. Hairy Vetch grown for a cover crop ; a low, dense cover, excellent for an apple orchard.

Fig. 3. Rape as a cover crop. Two feet of growth in two months. Holds snow well.

Fig. 4. Experimental Currant plantation. Forty-six varieties under test.

Fig. 5. Hardy perennial border—a very desirable feature on public or private grounds.

8. *Viburnum Opulus sterile.* Snow-ball. This a hardy free growing shrub about 10 feet high, which bears large round clusters of pure white flowers, which look like snow balls. In bloom about June 4th, and lasts over two weeks.

9. *Lonicera Tartarica.* Bush Honeysuckle. A very hardy symmetrical bush ten feet or more in diameter. Has an abundance of bloom every year, which appears the first week of June and lasts about a week. The bloom is followed by showy red or orange fruits, which make the bush attractive long after the bloom is gone. There are red, pink, and white varieties, all of which are worthy of a place on the lawn. Good varieties may easily be grown from the seed.

10. *Diervilla rosea.* Rose -colored Weigela. This is a handsome bush which is only half-hardy here when young, but becomes hardier with age. It makes a bush five or six feet in diameter. The flowers are large and bell-shaped, appearing among the foliage the first week in June and lasting nearly three weeks.

11. *Philadelphus coronarius.* Garland Syringe. A hardy, vigorous bush about ten feet in height, bears large white fragrant flowers like orange blossoms. In bloom about June 15th and lasts over two weeks.

12. *Rhus Cotinus.* Purple Fringe or Smoke tree. A hardy thrifty shrub which grows ten or twelve feet high and makes a shapely bush. About the middle of July it comes in bloom, and from then on till autumn, is covered with curious fringe or plume-like flowers which are very showy.

13. *Hydrangea paniculata grandiflora.* A somewhat straggling growing shrub, which may become six or eight feet high, but is better of being pruned back severely every spring, in the same way as roses. Bears large panicles of white flowers. In bloom about the middle of August and lasts three or four weeks.

Wax Models.

I am pleased to state that we have been able to retain the services of Mrs. Stanley Potter, our fruit model artist, and that she has made good progress during the year in adding to our collection of fruit and vegetable models. This collection is of great value to our students, and has been studied with interest by thousands of visitors. The varieties of the different kinds of fruits represented have now been classified and labelled so as to make the display as instructive as possible to visitors from all parts of the Province.

Acknowledgments.

In conclusion, I wish to gratefully acknowledge the faithful and efficient services of those who have labored with me to make the work of this department a credit to the College. Mr. H. S. Peart, Demonstrator, has proved himself an able and willing assistant both in the class room and out of it. Mr. William Hunt, florist, has shown great skill and judgment in the management of the greenhouses, and has also rendered valuable assistance as an instructor. Mr. William Squirrell, who, for thirty years has had charge of the garden and grounds, has established for himself a reputation of which any gardener might well be proud.

I wish also, Mr. President, to take this opportunity of congratulating you upon your appointment as President of this Institution, and to thank you in closing this, my first report to you, for the kindness and courtesy you have extended to me as one of your staff.

Respectfully submitted,

H. L. HUTT.

PART XII.

THE PROFESSOR OF BACTERIOLOGY.

To the President of the Ontario Agricultural College:

SIR,—I have the honor to submit to you my report on this year's work in the Bacteriological Department.

LECTURES.

The following courses of lectures to students were given during the year:

1. A course of 30 lectures on Bacteriology and its relation to Agriculture and Dairying for second year students.

2. An advanced course of lectures on the relation of Bacteriology to Agriculture and the infective diseases of animals for fourth-year students.

3. A special course of lectures on the bacterial diseases of plants and the bacterial decomposition of fruits, vegetables, and other plant substances for fourth-year specialists in Biology and Horticulture. (See Fig. 1 and 2.)

FIG. 1. Horticultural specialists studying bacterial diseases of plants, 1904.

FIG. 2. Plants of Hubbard Squash showing natural infection with *Bacillus tracheiphilus*. Note the drooped appearance of the leaves. Photo taken on Sept. 14th, 1904.

4. An extensive course of lectures on Dairy Bacteriology to the fourth-year specialists in dairying.

5. Twelve lectures to the special short-course dairy students.

6. Short course of lectures to the students of the special Creamery Course, and also a few lectures to the Dairy Instructors who have control of the inspection of creameries and cheese factories during the summer under the supervision of the Superintendent of Farmers' Institutes. Four lectures for milk dealers and producers.

7. Twelve lectures to the Domestic Science students from the Macdonald Institute.

8. Four lectures, with demonstrations, to the students in the short course on Poultry Raising.

Laboratory Work.

At present, our accommodation does not permit us to give laboratory work to the second-year students or to the fourth-year specialists in Agriculture. These classes, however, should have laboratory work in order to supplement their lectures, and in this particular the teaching of the subject of Bacteriology is behind that of other departments. As soon as sufficient accommodation is provided, laboratory work will be started with these classes. At present the following classes take laboratory work: The Horticulture and Biology specialists, the fourth-year specialists in dairying, the dairy instructors, special creamery course students, milk dealers and producers, the special dairy class, and Domestic Science students. The special dairy class received twelve half-days' laboratory instruction, and, as the class was rather large, the work had to be repeated two or three times in order to give all members of the class the same instruction. I have already pointed out the great waste of time that this procedure involves. Special laboratory work has been given to those fourth-year students who have taken their thesis work in my department. One of the specialists in dairying spent two months during the summer at work on his thesis in this laboratory.

Meetings Attended.

During the year I attended a number of conventions, and delivered addresses before several meetings and associations as follows:

1. The Dairymen's Association of Western Ontario. Addresss: "The Abnormal Flavors of Gathered Cream and Butter."
2. The Women's Institute of W. Middlesex. Address: "Bacteriology in its Relation to Domestic Science."
3. Canadian Association of Master Bakers. Address: "The Results of the Bacteriological Examination of 35 Samples of Canadian Flours."
4. The Ontario Bee-Keeper's Association. Address: "The Diseases of Bee Larvæ."
5. Buttermakers' Meeting of the Dairymen's Association of Western Ontario. Address: "Results of the Examination of a Number of Samples of Gathered Cream."
6. Short-Course Students in Stock Judging. Address: "Disinfection and Disinfectants."
7. The Ontario Library Association.

Papers were also sent to the Laboratory Section of the American Public Health Association and to the meeting of the Society of American Bacteriologists.

Publications.

During the year the Ontario Department of Agriculture has issued the following bulletins: Bulletin 136, "Some Bacterial Diseases of Plants Prevalent in Ontario," by F. C. Harrison and B. Barlow. Bulletin 137, "A Bacterial Disease of Cauliflower and Allied Plants," F. C. Harrison. The latter bulletin was also published in the II Abteilung of the Centralblatt fur Bakteriologie. Besides these publications, a number of less important articles and notes were contributed to various Canadian agricultural periodicals.

Routine Laboratory Work and Analyses.

During the year we have manufactured and sent out 105 doses of tuberculin, and 112 pure cultures, or starters, for cheese and buttermakers. We

have also made bacteriological analyses and diagnoses of the following substances and have reported the results to those sending in the material:

Diseased hens	22
" chicks	2
" ducks	2
" turkeys	2
" organs, pus, tumors, etc	10
Anthrax	3
Suspected diphtheria	5
Milk, off-flavored or suspected of causing disease	9
Off-flavored cheese	3
Cream	6
Off-flavored curd	2
Off-flavored starters	2
Viscid sugar-beet juice	1
Bronchial exudate	1
Discolored bread	1
Foul brood	1
Water	12
Butter, rancid, oily, fishy, etc	15
Spoiled canned goods	19
	124

In connection with this work, I might call your attention to the large number of samples of spoiled canned goods that we have received, as indicating the interest of some Canadian canners in the problems which they have to solve and which have, in most cases, a bacteriological solution.

Assistance.

Mr. B. Barlow, Demonstrator in this Department, has rendered very efficient service during the year. His time has been largely occupied in preparing material for the various laboratory classes and in research work, particularly on the nitrogen-fixing bacteria of legumes and the bacterial diseases of plants.

Fig. 3. Leaves of Mammoth White Hubbard Squash. Natural infection with *B. tracheiphilus*. The leaf on the left shows the more advanced stage of the disease. Photographed 15th Sept., 1904.

Fig. 4. Portion of a cucumber vine showing natural infection with *B. tracheiphilus*. Note the wilted appearance of the leaves. Photographed 15th Sept. 1904.

Research Work.

Several lines of investigational work have been conducted during the year. Bulletins 136 and 137 contain the results of a part of this work, but we have on hand a considerable amount of unpublished data which is, as yet, incomplete. At present we are working upon a rot of the potato, which has been very destructive during the past season, and upon perfecting the details with regard to the preparation of the various cultures necessary for inoculating the different species of legumes with nitrogen-fixing bacteria. We hope to be ready to send out cultures of these bacteria to all Ontario farmers who apply

FIG. 5. Fire or Twig Blight of the apple, showing natural infection through the twigs and blossoms, with the organism (*Bacterium amylovorum*) which causes this disease.

FIG. 6. A branch of Mountain Ash (*Pyrus acucipita lacineata*), showing natural infection with Fire Blight organism.

for them before the spring seeding. The results of the researches of the United States Department of Agriculture on the effect of these cultures upon legumes, and the publication of an article in the October Number of the Century Magazine, have resulted in calling attention to this important subject.

We intend to supply cultures for the following legumes: Red Clover, White Clover, Pea, Vetch, Soy Bean, Field Bean, and Alfalfa or Lucerne.

During the past season some bacterial diseases of plants were very common in this neighborhood, and we have made some progress in experimental work with these affections. In order to permit horticulturists and others to recognize and identify these diseases, Mr. B. Barlow, Demonstrator in Bacteriology, has prepared the following notes giving some of the symptoms of these diseases, and the results of a few experiments.

Cucumber Wilt. (Caused by *Bacillus tracheipilus*). A bacterial disease of the cucumber and of plants related to it has been prevalent during the past season in the gardens of the Horticultural Department and in the neighborhood. It has injured and killed vines of the cucumber, squash, and pumpkin.

The germ causing this disease, *Bacillus tracheiphilus*, has been known and studied for some years. The disease may be recognized by the sudden wilting of the leaves when the weather is not dry, and when plants not infected remain erect and fresh-looking. At first the blade of the leaf droops on its stem in the sunshine, but partly recovers at night. (Fig. 2.) After a few days the blade wilts and hangs down limp and flaccid around its stem or petiole. (See Fig. 3). In a few days more it withers and turns brown and dry like parchment. The leaf stem dies and dries up slowly from the top downward, but remains erect, wrapped by the withered leaf blade. The disease progresses in the vine in the direction of growth and kills the leaves in succession. (Fig. 4.) The plant may die or may continue to bloom from the upper axils, and some fruits may set; but these wither or reach a length of a few inches or they become distorted and deformed.

The characteristic bacilli are found in great numbers in all parts of the diseased and wilted plants, in root, stem, leaf, flower, and fruit.

Cucumber fruits may attain a large size and good shape and then be overtaken by the disease. At first sight such fruits appear fair and sound, but on looking closer translucent areas are seen mottling the rind, and when the underlying translucent tissue is crushed it draws out in slimy threads. On breaking the fruit across, the vascular bundles, which traverse the fruit lengthwise, are found to be softened and slimy. The seeds may be full sized, but they also are slimy, and when examined are found to be loaded with the bacteria which cause the disease. Healthy plants of cucumber, musk-melon, and summer squash were inoculated with pure cultures from wilted vines of winter squash and cucumber, and these inoculated plants wilted.

We have found a short and easy way by which the gardener can determine whether or not his vines are suffering with this bacterial wilt. First, break a wilted vine, and if the juice is slimy and draws out in slender threads from the broken ends it is safe to conclude that this wilt disease is at work; but if not, or if further evidence is wanted, proceed as follows: Gather some young, tender fruits of squash, pumpkin or cucumber from healthy vines, break off a piece of stem from a wilted vine, take a wire, or better a hat pin, heat it red hot, let it become cold and thrust it first into the broken end of the piece of stem from the wilted vine and then into the young fruit. Another good way is to cut into and break open a young fruit, heat the pin red hot and let it become cold, thrust it into the broken end of a piece of wilted stem, and then use it to scratch and puncture the broken surface of the young fruit. If more than one wilted vine is to be tested, the pin or wire must, of course, be heated

red hot before beginning a new test, otherwise the bacteria from the first may be carried over into the second test. Put the inoculated fruits into a pail with a wet cloth in the bottom, cover the pail and set it aside for four or five days.

Bacterial cucumber wilt will be indicated as follows: There will be a pearly white, viscid, bead-like drop of bacterial growth exuding from the punctures and a sharply defined, cylindrical, water-charged portion or core around each puncture. If this translucent tissue be touched it will be found slimy and will draw out in slender threads. The scratches on the broken surface of the young fruit will show a watery discoloration of the tissue for some distance on both sides of the scratch and there will be small pearly white drops or beads of viscid growth, dotted over the discolored area but not beyond it. Later, this white, viscid growth appears along the scratch, and the bead-like drops increase in size and run together. After some days longer the whole fruit softens into a slimy mass. If these symptoms develop in the inoculated fruits, the gardener may be assured that his vines are suffering from bacterial wilt, and he may as well pull up the wilted vines and burn them. To prevent its farther spread, he should take measures to destroy the squash bugs and the striped cucumber beetles; for Erwin F. Smith has found that these insects carry the germs from diseased to healthy plants.

It may be that the seeds sent out by seedsmen carry with them the living germs of the disease and that these germs can live in the soil of the garden from season to season.

Black Rot of the Cabbage. (Caused by *Pseudomonas campestris*). The bacterial disease of the cabbage and related plants, known as Black Rot, has been prevalent for some years at the College and in the neighborhood. This season it has done injury to early and late cabbage and cauliflower in the garden of the Horticultural Department and in other gardens in the vicinity. It was also found affecting, but not seriously injuring, a field of rape belonging to the Farm Department. A large field of Swede turnips on a farm near the College was also affected. Near the College are two neighboring gardeners, one raises his own cabbage seed and in his field we could not find a single cabbage infected with Black Rot. He says that his cabbages have never had this disease. His neighbor about half a mile distant buys seed each season and over 90 per cent. of his cabbages were affected this season. Some plants were killed outright, and many were so injured as not to form heads. He says that his cabbages have suffered from the disease for many seasons. He returns the refuse from the cabbages to the soil, a bad practice, as it seeds the soil with the rot organism.

A Bacterial Disease of the Bean. (Caused by *Pseudomonas phaseoli*). This bacterial disease of the bean has not been prevalent during the past season at the College. However, a small plot of beans seriously affected with this disease was observed near the College. The owner of the garden said that beans had not been grown on that ground for many years, never to his knowledge. The seed, which was advertised as a novelty, was bought in Hamilton. It may be in this case that the germs of the disease were carried in the seed.

Fire Blight. (Caused by *Bacterium amylovorum*). The blight of the the pear and apple has been observed this summer at the College and in neighboring orchards, and also in numerous other parts of the Province. At the College it has been found affecting the apple, pear, and Mountain Ash. (Figs. 5 and 6). From all of these trees the bacterium causing the disease has been obtained in pure culture, and successful inoculation experiments have been carried on. The bacterium has been isolated in pure culture from blighted leaves of the pear and inoculated into young, healthy shoots of pear trees

where it soon causes typical blight. The same bacterium has been isolated repeatedly from apple trees affected with "twig blight", and the inoculation has produced blight in the growing shoots of the pear and quince. In like manner, the germ isolated from the Mountain Ash caused blight when inoculated into pear shoots. For further information regarding Fire or Twig Blight and some other bacterial diseases of plants, see Bulletin 137, published by the Ontario Department of Agriculture, Toronto.

Soft Rot of Cauliflower and Cabbage. (Caused by *Bacillus oleraceae.*) This disease, which was fully described in Bulletin 136, was present in several gardens in this vicinity during the past season. It occurred alone, and not associated with the Black Rot of the Cabbage.

The Experimental Work of the Bacteriological Department from 1895 to 1903.

About 1893, the Experiment Station of the University of Wisconsin appointed a Bacteriologist to investigate problems connected with the Dairy Industries of that state, and to give lectures and demonstrations to the agricultural students. Shortly after this appointment, the present Minister of Agriculture for the Province of Ontario, the Hon. John Dryden, visited Madison, Wisconsin, and was so impressed with the value of the instruction given there in pasteurizing milk and general dairy bacteriology that he thought it necessary to organize a bacteriological department at the Ontario Agricultural College. This led to the installation of a Bacteriological Laboratory at the College; but it was not until 1899 that the Bacteriologist devoted his whole time to the subject of Bacteriology. For the four years, 1895-1898 inclusive, all the microscopical work conducted at the College was done in the bacteriological laboratory; this included animal and vegetable histology, cryptogamic botany and plant pathology, and for several terms instruction was given in systematic and physiological botany and plant breeding. These subjects are now taught in the departments to which they rightly belong, and the services of at least two instructors are now required to give the above mentioned subjects the attention they deserve.

During these years, in which botany engaged so much of our attention, two bulletins were published, "The Grasses of Ontario," and "The Weeds of Ontario". The latter, revised by Prof. Lochhead, has just been reprinted by the Ontario Department of Agriculture. In addition to the preparation of these bulletins, some work was also done on the fungous diseases of greenhouse crops; on the effect of spraying Bordeaux mixture on foliage, and on fruit preservatives for exhibition purposes.

Mention must also be made of a large collection of microscopical material, consisting of various stems, roots, leaves, buds, ovules, embryos, which were prepared, stained, and imbedded in paraffin, and cellodin for class work. A part of this collection of over 250 specimens was subsequently transferred to the Biological Department, and many of our present students are still using portions of this collection.

In 1896 research work in Dairy Bacteriology was started, and a short paper on the bacterial contamination of milk was contributed to the College Report for that year, and owing to the great importance of the Dairy Industry of the Province, more or less investigation of some phase of dairy work has been in progress ever since.

In 1898 a Thistle milking machine operated by steam power was in more or less constant use in the College Dairy stable. This machine operated naturally, quickly, thoroughly, and without any annoyance to the cow; and many

opinions were expressed by various Dairy associations that the use of the machine would strike a blow to hand milking, and further that the use of the machine would guard against the entry of all dirt, and that "machine milk" would be absolutely filth free, and consequently little or no souring would occur. In order to settle all dispute, the purity of the milk was tested —by bacteriological methods—immediately after being drawn by hand and also immediately after being drawn by the milking machine. The result of 235 analysis of "machine-drawn milk" gave an average of 153,000 bacteria per cubic centimetre, while the average of 98 analysis of the hand-drawn milk gave 12,000 bacteria per c.c Further experiments showed that machine-drawn milk contained very many injurious species of bacteria which seriously impaired the flavor of butter and cheese made from such milk.

The investigations of bacterial life in normal and abnormal cheddar cheese may be grouped together. Of late years, no subject has awakened greater interest than an explanation of the curing or ripening changes which occur in normal cheese. As a result of numerous investigations of cheeses made in the United States, England, Switzerland, etc., we know a great deal about the changes which occur when cheese ripens, that is to say, when it changes from an insoluble, indigestible, tasteless mass to a soluble, more readily digested, palatable product. These changes are brought about by the digestive action of rennet, which is favored by the growth of the lactic acid bacteria in cheese. The investigational work on the particular type of cheese made in Canada related to the number and kind of bacteria which were present in the cheese. Numerous samples of cheese obtained from all over Ontario were bacteriologically examined in order to obtain information as to the normal bacterial flora. Following this work, a quantitative determination of the lactic acid bacteria was made in a series of cheeses analysed at various ages, and the result of this work was summarized and published in the Transactions of the Canadian Institute for 1900.

The interest aroused by the good results of the cool curing and cold curing of cheese suggested further experiments in order to find out the effect of various temperatures upon the bacterial life in cheese. In this work, we had the co-operation of Dr. Connell, Professor of Pathology of Queen's University, and as a result of more than 300 analyses of cheese cured at different temperatures we were able to announce "that the bacterial content of cheese remains high for the longest time, and the decline is also most gradual, in cheese kept in ice cold storage at an average temperature of 40 degrees F. In cheese kept in a cool well-regulated room, similar results occur but the decline in the number of bacteria is more rapid. As this higher bacterial content constantly corresponds with a better flavor in the cheese, we infer that it is the chief factor in determining the flavor of cheese made from good pure milk."

A number of studies of abnormal fermentations of cheese have also been made. The most extensive of these had reference to an infection known as "bitter" cheese. An organism new to science was discovered which produced this affection, its habitat, life history and cultural peculiarities worked out and remedial measures suggested. Other so-called "cheese diseases" have been investigated, such as the abnormalities known as "mottled cheese", "fruity cheese," "rancid cheese." In the last named trouble, the infection was found to be a bad water supply.

The constant presence of bacteria in freshly drawn milk is a matter of considerable importance, as it explains the ineffectual attempts to obtain milk in commercial quantities uncontaminated by bacteria. The bacterial flora of freshly drawn milk has been the subject of several of our investigations. Samples of fore-milk of a number of cows were carefully collected in sterile tubes

and studied as regards the number and species of bacteria present, and evidence was brought forward which pointed toward bacterial infection by way of the blood or lymph rather than through the teat.

The efficiency of several makes of continuous pasteurizers operated at different temperatures was the subject of a number of tests. The average number of bacteria per cubic centimetre found in milk pasteurized at 140 degrees F. was 631,000, at 160 degrees F. was 17,800, at 185 degrees F., was 81, and at 195 degrees F. was 40, and as a result of these tests, pasteurization of milk at 185 degrees was advised as the best method of securing uniformity, keeping quality, and the mild flavor requisite for export butter.

Several years ago, clarified milk, or milk that has been passed through a separator, was quite extensively advertised by some milk dealers. They claimed that this operation reduced the number of bacteria and enhanced the keeping quality of the milk. This claim, however, was at variance with the reports of a number of investigators, who showed that centrifugation did not decrease the number of bacteria in milk. At the suggestion of the Ontario Department of Agriculture, we investigated this subject, and averaging the results of 240 analyses found that there were 400,000 bacteria per cubic centimetre more in centrifuged milk than in the same milk before centrifugation. Further, there were nearly 25,000 more liquefying (putrefying) bacteria per c. c. in the centrifuged milk. This paradoxical result is explained by the fact that bacteria in milk exist in clumps and masses and the centrifugal force breaks up and distributes them through the milk. These results fully confirmed those of other investigators.

Ontario, as well as other countries, has long suffered from a disease of bee larvae, known popularly as "Foul Brood," and the destruction of bee stock by this disease and the discouragement arising therefrom, has been one of the greatest influences that has retarded the development of the bee industry. Although this disease has been known since the time of Aristotle (B. C. 340) it was not until the year 1885 that the true cause of the disease was discovered. This disease has been studied in our laboratory by bacteriological methods, and we also had the opportunity of comparing the various characteristics of the disease as it occurs in Europe and America. Additional facts in the life history of *Bacillus alvei*, the cause of Foul Brood, were discovered, the various methods of cure were compared and explained, and a new remedy, known as the formalin treatment, suggested, which has given excellent results.

We have also given a little study to that important disease, tuberculosis.

First, we may mention the preparation of a tuberculin which would give reactions in animals extensively diseased, and also in animals which have been previously inoculated with tuberculin in order to mask the effect of an official test. Owing to the lack of a proper isolation stable, this work had to be stopped when we were on the point of obtaining important results.

A number of tests of milk coming from tubercular cows have also been made. Our results corroborate the conclusions of Rabinowitch and others,—that the milk obtained from cows, which react to tuberculin, but which do not show clinical symptoms of tuberculosis or tubercular mastitis, may contain the tubercule bacillus in sufficient numbers to cause death in guinea pigs inoculated with it.

Two investigations have been made on the duration of the life of the tubercle bacillus in Emmenthaler and Cheddar cheese. The results of these experiments showed that the tubercle bacillus died out between the thirty-third and fortieth day in cheese made after the Emmenthaler method, and between the sixtieth and sixty-second day in cheese made after the Cheddar method, and hence if the latter cheese happened to contain tubercle bacilli naturally pres-

ent, it may be assumed that none of these bacteria will be living when the cheese becomes ten weeks old. Therefore, no danger need be apprehended of acquiring the disease known as consumption by eating well cured Cheddar cheese.

During the last five years, we have made more than 500 post mortem examinations of diseased fowls. About 300 of these examinations were made on fowls suffering from, or dead from, a disease which is commonly called "Roup." From the careful study of these diseased fowls, and also from the inoculation experiments with healthy fowls and pigeons, we were able to show the infectious nature of the disease. We were also able to produce the disease, with all its varied symptoms, by the inoculation of a new germ which was isolated from diseased hens, and which we have named *Bacillus cacosmus* (ill-smelling), into the tissues of healthy fowls and pigeons. We have also produced Roup by the inoculation of another organism, which is well-known as the blue pus germ, *Bacillus pyocyaneus*, and hence we have regarded Roup as simply a complex suppurative process which differed from ordinary forms of suppuration in that the pus in fowls appeared in the form of a solid, cheese-like, yellowish white mass, without any tendency to become soft or liquid, or to perforate the surrounding skin. Methods of prevention were advocated and a treatment suggested by which the milder forms of the disease could be cured.

In this connection, we may also mention experimental work on the supposed identity of human and avian diphtheria. We have shown that diphtheria antitoxin inoculated into birds suffering from fowl diphtheria produced no practical or permanent results, and the inoculation of healthy fowls with human diphtheria bacilli showed that this bacillus was not disease producing for hens.

This evidence, together with the isolation of the Roup bacillus, *B. cacosmus*, and the blue pus germ, *B. pyocyaneus*, and the production of typical fowl diphtheria by the inoculation of either of these bacteria into healthy birds, showed life unsoundness of the theory of those who believed in the identity of human and avian diphtheria.

Although one important bacterial disease of plants has been known in Canada for some years, yet comparatively little study has been given to plant affections induced by bacteria.

During the last year or two, however, we have recognized some five or six bacterial plant diseases in Ontario, some of these are well known in the United States, but one of them is a new disease, which has been worked out in this laboratory. This disease is a soft rot which has done much damage to cauliflowers, cabbages, and white turnips, and is caused by a bacillus (*B. oleraceae*) which has the power or property of dissolving the cell wall of the infected plant, thus separating the cells and breaking them down into a soft, pulpy mass.

Several other diseases of this nature have been investigated, and further research along these lines is at present in progress.

I cannot close this article without recording my appreciation of the efforts of my former assistants, Messrs. McCallum, Ross, Streit, and my present assistant, Barlow, who have labored with dexterity, skill, and readiness in the various research work which the Bacteriological Department has undertaken. I have in writing this paper used the plural "*we*" in order to include these gentlemen, and I append a list of the more important papers, etc., published, which will give some idea of the work that has been done and in which, as will be seen, some of my assistants have shared:

Bacterial Content of Hailstones, by F. C. Harrison. Botanical Gazette 1898. 26. No. 3.

Le Lait trait a la machine et lait trait a la main, by F. C. Harrison. Annales de Micrographie, 1898, No. 11 and 12.

Tuberculosis in Cattle, by F. C. Harrison. Special Bulletin, Toronto, 1897.

La duree de la vie du bacille de la tuberculose dans le Fromage, by F. C. Harrison. L'Annuaire Agricole de la Suisse, 1900.

Foul Brood of Bees, by F. C. Harrison. Ont. Agri. Coll. Bull. 112. Toronto, 1900.

La Loque des Abeilles. Nyon. (Suisse). 1901. Also in German and Russian.

The Agglutinating Substance, by F. C. Harrison. Centralblatt fur Bakteriologie I. 1901, 30 No. 3.

The Duration of the Life of the Tubercle Bacillus in Cheese, by F. C. Harrison. 19th Report of the Bureau of Animal Industry, Washington, 1902.

Yeast and its Household Use, by F. C. Harrison. Ont. Agr. Coll. Bulletin 118, Toronto, 1902.

Pasteurization of Milk for Butter-making, by F. C. Harrison and H. H. Dean. Ont. Agri. Coll. Bulletin 117, Toronto, 1902.

Bitter Milk and Cheese, by F. C. Harrison. Ont. Agri. Coll. Bulletin, 120. Toronto, 1902. (Also in French).

The Bacterial Flora of Freshly Drawn Milk, by F. C. Harrison and M. Cumming. Journal of Applied Microscopy, V., Nos. 11 & 12, VI. No. 1.

Ripening of Cheese in Cold Storage Compared with Ripening in the Ordinary Curing Room, by F. C. Harrison, H. H. Dean, and R. Harcourt. Ont. Agri. Coll. Bulletin, 121, Toronto, 1902.

Preliminary note on a new organism producing Rot in Cauliflower and allied Plants, by F. C. Harrison. Science, N. S., Vol. XVI; p. 152, 1902.

The Ripening of Cheese and the Role of Micro-organisms in the Process, by F. C. Harrison. Transactions of the Canadian Institute, 1900-1, pp. 103-134.

Roup, by F. C. Harrison and H. Streit. Ont. Agri. Coll. Bulletin, 125 Toronto, 1902.

The Supposed Identity of Human and Avian Diphtheria, by F. C. Harrison. Proceedings of the American Public Health Association, 1902.

Proceedings of the American Public Health Association, 1902.

The Bacterial Contamination of Milk and its Control, by F. C. Harrison. Transactions of the Canadian Institute 1902-3, pp. 467-502.

Bacillus mesentericus et B. alvei, by F. C. Harrison. La Revue Internationale d'Apiculture, 1903, No. 2.

Bacterial Content of Cheese Cured at Different Temperatures, by F. C. Harrison and W. T. Connell. Ont. Agri. Coll. Bulletin 130. Toronto, 1903.

Roup: An Experimental Study, by F. C. Harrison and H. Streit. Ont. Agri. Coll. Bulletin, 132. Toronto, 1903.

Some Bacterial Diseases of Plants Prevalent in Ontario, by F. C. Harrison and B. Barlow. Ont. Agri. Coll. Bulletin, 136. Toronto, 1904.

A Bacterial Disease of Cauliflower and Allied Plants, by F. C. Harrison. Ont. Agri. Coll. Bulletin, 137. Toronto, 1904.

Reports of the Bacteriologist, by F. C. Harrison. Ont. Agri. College Annual Reports 1896-1903.

I have written this article on the experimental work of the Bacteriological department to call attention to the diversity of our work, and as a plea for a larger and more modern building. In addition to the research work, our routine work—(the preparation of tuberculin, pure cultures of lactic acid bacteria for the use of dairy men, nitrogen-fixing bacteria for the inoculation of legumes, and the examination of various substances and material submitted

for diagnosis, etc.) needs much space, and the laboratory is not large enough for this; and when in addition we have classes and laboratory work for an increasing number of students, it shows that the time has come for the erection of a new building to be devoted to bacteriology.

Last year I pointed out what a number of the United States Agricultural Colleges were doing, spending from $30,000 to $50,000 on new Bacteriological laboratories, and I understand that the new Agricultural College, founded by Sir William Macdonald for the English speaking residents of the Province of Quebec, is to have a modern and well equipped laboratory for bacteriological research.

Hoping that the coming year will see the commencement of a new Laboratory.

I have the honor to be,

Your obedient servant,

F. C. HARRISON.

PART XIII.

PROFESSOR OF FIELD HUSBANDRY AND EXPERIMENTALIST.

To the President of the Ontario Agricultural College:

SIR,—I have the honor of submitting herewith my report of the work done in the department of Field Husbandry for the year 1904. This is my eighteenth annual report since I became connected with the experimental work at the College, my twelfth annual report as Director of the Experimental Department, and my first report as Professor of Field Husbandry.

The growth of the experimental work from 1886 to 1904 is shown by the fact that the number of experimental plots has been increased from fifty-four to about two thousand. During this same period, the co-operative experimental work has been increased from twelve experimenters in 1886 to four thousand and fifty experimenters in 1904. I am grateful for the confidence placed in me, as shown by the fact that, besides the directorship of the experimental work at the College and that of the co-operative experimental work in agricul-

A partial view of the Experimental Grounds. Practical Farmers receiving Practical Information along the lines of Practical Agriculture.

ture throughout Ontario, I have also been placed in charge of the lectures in field agriculture or agronomy at the College. I appreciate the honor thus conferred upon me, and earnestly hope that the prosecution of the work along these three very important lines may not prove too heavy a task, but that it may be gradually and substantially developed along the right lines.

The division of the work of the College Department of Agriculture into Animal Husbandry, under Prof. Day, and Field Husbandry, with myself in charge, has occasioned some changes in the staff of the Experimental Department. Mr. John Buchanan, B.S.A., who was formerly Specialist in plant breeding, was advanced to the position of Demonstrator; Mr. W. J. Squirrell, who was assistant experimentalist, was advanced to the position of Specialist in plant breeding; and Mr. H. G. Bell, the student who was highest in general proficiency of the junior class of last year, was appointed assistant experimentalist. These gentlemen, as well as the foreman, Mr. A. E. Whiteside, and the stenographer, Miss M. Laughlin, have all shown a deep interest in the work of the department, and have rendered excellent service within the past year.

Outline of the Work in Field Husbandry, for 1904.

(1) The delivering of lectures to the students taking the four-year course, which is outlined in the College circular; also to the students taking the dairy course, those taking the short course in stock and grain judging, and those taking the Nature-Study course at the Macdonald Institute.

(2) The delivering of lectures to various gatherings of farmers, as indicated by the following: Fifteen or twenty in the experimental grounds to the thousands of excursionists who visit the College in the month of June; three at Seed Fairs at Guelph, Milton, and Markham; two at the Model Fair at Brome, Que.; one at the Provincial Winter Fair, Guelph; one at the Eastern Winter Fair, Ottawa; one at the annual meeting of the Canadian Fairs' Association, Toronto; two at the Ontario Agricultural and Experimental Union; one at the Niagara County Farmers' Club in New York State; one at the Plant Breeders' Convention at St. Louis, Mo.; and one at the annual meeting of the American Association of Farmers' Institute Workers at St. Louis, Mo.

(3) The conducting of practical experiments in field agriculture on about 2,000 plots at the Ontario Agricultural College.

(4) The carrying on of quite an extensive system of plant breeding, including both systematic selection and cross fertilization. In connection with the work in plant breeding, the discoveries of Mendel, as well as the investigations of De Vries, Bateson, and Correns are taken into consideration.

(5) The directing of co-operative experiments on 4,050, farms throughout Ontario. The report of the results of this co-operative work can be found in the Annual Report of the Ontario Agricultural and Experimental Union.

(6) The furnishing of plans, seeds, and instructions for illustration plots on the exhibition grounds at Simcoe, Whitby, Renfrew, Owen Sound, and Richmond.

(7) The writing of agricultural reports and articles. This includes the reports of the Experimental Department of the College and of the co-operative experimental work throughout Ontario, and the agricultural articles which are sent to the farm journals and newspapers occasionally throughout the year.

(8) The carrying on of a heavy agricultural correspondence. During a part of the year, the letters received daily number between one and two hundred. Many enquiries on agricultural subjects are received, which require much thought and care in answering.

(9) The judging of farm crops at agricultural exhibitions. In 1904, the writer acted as judge on farm crops at the Canadian National Exhibition, Toronto; the Eastern Winter Fair, Ottawa; the Provincial Winter Fair, Guelph; the Fall Fair, Guelph; the Fall Fair, Brome, Que.; and the Annual Seed Fair, Guelph.

(10) The assisting in the establishment of the Canadian Seed Growers' Association which was formed out of the Macdonald-Robertson Seed Growers'

Association within the past year. At a meeting of the representatives from different parts of the Dominion, which was held in the city of Ottawa in the month of June, the writer was appointed a member of the executive board of the new organization, and acted as chairman of the committee which decided on the constitution and by-laws to govern the Canadian Seed Growers' Association. The Ontario members of this Association held a meeting in Guelph on the 7th of December, at which the writer was chairman.

Experimental Work at the Agricultural College.

The work in the Experimental Department consists in planning the various experiments; laying out, seeding, and looking after the field plots; harvesting, threshing, weighing, and testing the grain; taking up, weighing, counting, testing, and storing the potatoes and roots; cutting, weighing, and harvesting the grass, corn, and fodder crops, etc., and also in picking by hand the samples of grain grown on the plots, some to be sown on the plots the following year, and some to be distributed for co-operative experimental work throughout Ontario. But few people realize what a large amount of very careful thought is required in planning, supervising, and examining these plots, and in studying, comparing, and summarizing the results for presentation in reports, bulletins, newspaper articles, and lectures.

Japanese Barnyard Millet grown on Exhibition Grounds at Brome, Quebec, from seed furnished from the Ontario Agricultural College.

Experimental Grounds. About fifty acres of land, divided into about 2,000 plots, is used for agricultural field experiments, conducted with varieties of grain, roots, tubers, grasses, clovers, fodders, silage, and miscellaneous crops; with artificial, green, and farmyard manures; with methods of cultivation, selection of seed, dates of seeding, etc.,—all with the greatest care, and for several years in succession—in order to secure strictly accurate and reliable results. These experiments deal with the crops grown on over nine-tenths of the cultivated land in Ontario, that is, fully 10,000,000 acres.

Experimental Plots. The experimental grounds have a gentle slope towards the southwest, and the soil is what might be termed an average clay loam. Nearly one-quarter of the land is manured each year with twenty tons (about twelve loads) of farmyard manure per acre. It will thus be seen that the most of the land receives farmyard manure once every four years. No

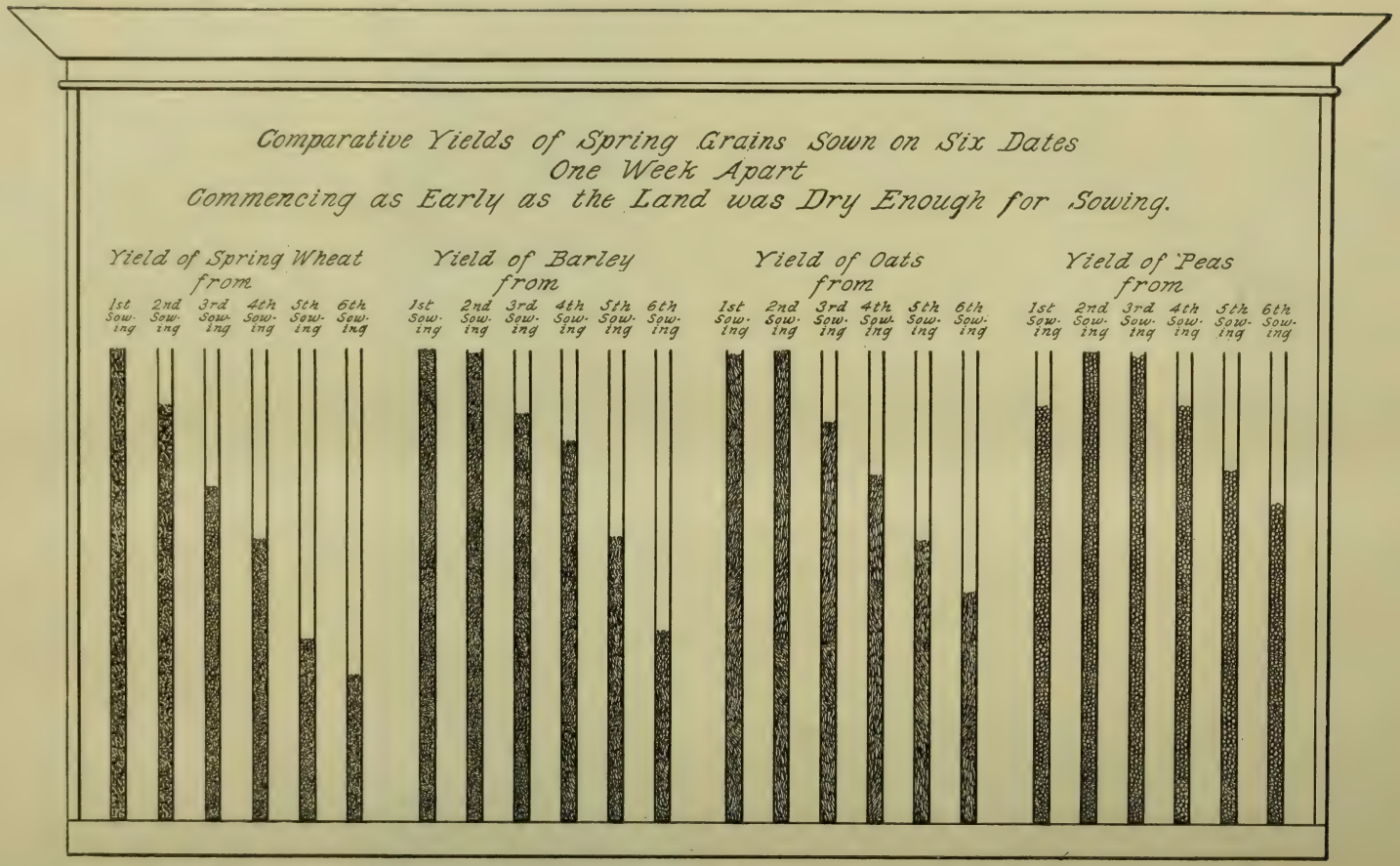

Comparative Yields of Spring Grains Sown on Six Dates
One Week Apart
Commencing as Early as the Land was Dry Enough for Sowing.
Yield of Spring Wheat from
Yield of Barley from
Yield of Oats from
Yield of Peas from
1st Sowing
2nd Sowing
3rd Sowing
4th Sowing
5th Sowing
6th Sowing

Diagram illustrating one of the cases in the Agricultural Museum at the College, showing the average of Five Years' result in sowing Spring Grains at different dates.

commercial fertilizers are used except in distinct fertilizer experiments, which occupy from two to three acres each year, and on which tests are made to ascertain the comparative value of different fertilizers with different crops. The plots vary in size according to the requirements of the different experiments, and the yields per acre are determined from the actual yields of the plots in every instance.

Results of Experiments.

All our field experiments are conducted for at least five years before any of them are dropped. For the results of many of the tests which were carried on for five years previous to 1904, the reader is referred to former reports. The results of some of the experiments which have as yet been conducted for only one or two years have been held back until the tests could be carried through at least another summer. As different seasons vary so much in temperature, amount of rainfal, etc., the average results of experiments continued for several years are of much greater value than those secured from only one year's work. We have submitted in bulletin form the results with much confidence in their reliability, and in their real practical value. The writer has had good reason to believe that the work of the Experimental department is being appreciated by the farmer of the Province, and that the results are being studied more and more each succeeding year. I have limited my remarks on each separate experiment, the results of which are presented in Bulletin No. 140, to a few of the points which seem to be of the greatest value to the agriculture of Ontario.

The table of contents of the bulletin is here presented, in order that the reader may know whether or not the information which he wishes to secure is likely to be found in the bulletin, copies of which can be obtained from the Department of Agriculture, Toronto, Ontario.

Experimental Work at the Agricultural College
Results of Experiments
Conditions of the Weather During the Past Summer
Fluctuations in the Areas of Farm Crops in Ontario
Yields per Acre of Different Classes of Grain
Barley
Oats
Wheat
Rye
Buckwheat
Field Peas
Field Beans
Soy, Soja, or Japanese Beans
Horse Beans
Grass Peas
Cow Peas
Hairy Vetches for Seed
Alfalfa for Seed Production
Corn for Grain
Sorghum for Seed
Millet for Seed
Sunflower Seed
Flax Seed
Sowing Spring Grains on Six Different Dates
Growing Grains in Mixtures for the Production of Grain and Straw
Mangels
Sugar Beets
Field Carrots
Swede Turnips
Fall Turnips
Parsnips
Kohl Rabi
Potatoes
Corn for Fodder and for the Silo
Sorghum for Fodder
Sunflowers for Fodder
Millet for Green Fodder and for Hay
Rape, Kale, Cabbage, etc
Green Fodder Crops
Winter Sowing of Winter Rye, Hairy Vetches, and Crimson Clover for Fodder Production
The Wild Vetch as a Fodder Crop
Annual Crops for Pasture Purposes
Grasses and Clovers

Respectfully submitted,

C. A. ZAVITZ.

One of about fifty companies of farmers who visited the Experimental Plots in the month of June.

Class of students at the close of a practical lesson in grain judging.

PART XIV.

THE MANAGER OF THE POULTRY DEPARTMENT.

To the President of the Ontario Agricultural College:

SIR,—I have the honor to present herewith the report of the Poultry department for the year 1904.

The usual course of lectures was given to the regular College students. The time allowed for this work, according to the time-table as now issued, is not sufficient to give the students as many lectures as the subject requires.

The poultry industry during the past few years has grown, and the interest taken in it has increased, and I think the subject should be given more attention than has been done heretofore.

The attendance at the Short Course in Poultry Raising was as large as we could handle to good advantage. There were some twenty or more students who took the course. Of course much larger numbers than this

can be accommodated for class-room work, but to give students practical work is a difficulty that is hard to overcome where more than twenty-five students are admitted. It might be wise for us to give a year's course, largely on practical work, so as to fit students to take charge of poultry plants for themselves. There are a number of people who are thinking of going into poultry-raising as a business, and who are wanting instruction of this kind.

Special lectures in the Short Course were given by Frank Hare, Quincy, Ill., (formerly of Ottawa); Wm. McNeil, London, Ontario; L. H. Baldwin, Deer Park, Ontario; Newton Cosh, Port Dover, Ontario; W. J. Bell, Angus, Ontario, and A. W. Tyson, Guelph.

The correspondence in connection with the Department has increased from year to year. This, in my estimation, is an indication that the farmers in general are taking more interest in poultry keeping.

Eggs and dressed poultry have sold at prices somewhat higher than in previous years. There seems to be a scarcity of eggs in most local markets. The community at large appears to be consuming more eggs and poultry. This, of course, stimulates our home markets, which is very desirable.

Hatching Eggs in January.

We set a large number of eggs during the month of January, or while the Short Course students were in attendance. The eggs this year varied greatly in fertility. We had eggs from five different breeders in the Province, as well as from our own hens. The eggs were secured from outside parties largely as a matter of noting what effect different systems of housing and feeding had upon the fertility of the eggs. In some instances where the chickens were housed in what might be termed "warm houses," the fertility was extremely low, and in one or two instances no chickens were hatched from the eggs. This, of course, is a very serious loss. We got the best eggs for hatching where the fowls had exercise in the fresh air. The eggs during the past winter did not hatch so well as during the previous winter of 1903, nor were the chickens as thrifty. The hatching of chickens during January has never been a paying proposition at this department, with the exception of one year. The great difficulty is to secure good hatchable eggs and chicks which have vigor. Eggs low in fertility usually hatch chicks low in vitality, which is followed by large losses. Our experience so far would indicate that when eggs are selling at 25 cents a dozen or better, they are more profitable than setting them with a view to the hatching of chickens to be sold as broilers.

Later Hatching.

During the natural hatching season, which might be termed the months of April, May and June, we used both hens and incubators for hatching purposes. This is the first year that the hens have hatched a much higher percentage than the incubators. The extremely cold winter appeared to have the effect of lowering the general vitality of the stock, which resulted in a shortage of good hatchable eggs until about the last week in April. We are short of early hatched pullets, and no doubt we will be short of winter eggs.

We used the hens for much the same purpose as in previous years, that is, in hatching eggs laid by individual hens from which we desire to raise as large a number of chicks as possible. These special mating chickens

are all marked between the toes in such a manner as to indicate how the chickens are bred. This is the only satisfactory method that I know of for keeping track of the breeding chicks.

New Houses.

Various styles of poultry houses have been discussed at length in the poultry press during the past two or three years.

In years gone by, it was considered absolutely necessary to have a warm house in order to get eggs in winter. After many years, experience with this kind of house, poultrymen have found that they were not all that could be desired. There was a tendency for the air in the house to become foul, or what is known by some as "stuffy." The walls in many cases were damp, due to the moisture condensing. Some poultrymen have been of the opinion that these houses lessen the general vitality of fowls, and are in a measure the cause of many poor hatches.

In the past three or four years, the fresh-air houses have been strongly advocated. Some writers have gone so far as to say that all a fowl needs is protection from the wind, and to be kept out of direct draughts, and that the temperature has no influence at all upon egg production. There are also a few who claim that fowls eat no more in a cold house than they do in a warm one. This, of course, appears to be absurd. It is claimed by the advocates of the fresh-air houses that fowls are healthier, more eggs are laid during the winter, and better hatches of stronger chicks are secured during the spring.

With the object of solving some of these problems, there have been constructed at this Department four poultry houses. One of these is what might be termed the "warm house," and is built of matched lumber, lined with paper. There is a dead air space between the inside wall and the outside wall. The building is made tight. The plan adopted to do away with the moisture in the inside of the building is the use of straw as a ceiling. This straw is, of course, placed on boards, which are some six inches apart. It is expected that the straw will absorb the moisture and keep the house dry.

Another house is what is known as the "Maine State" house. This house is practically open to the weather on the front or south side. There are canvas curtains which can be dropped as a protection against wind and snow on stormy days. On other days these canvas curtains are to be kept rolled up, and the fowls allowed to exercise in the fresh air. The ends of the house are single ply matched lumber; the back wall of the house is matched lumber lined with paper and is sheeted again on the inside. This is done in order to make a warm roosting coop, which is protected at night in front by canvas curtains.

The third house is known as the "Closed Pen" style. This house is built much the same as the second house mentioned, but in place of the front side being entirely open to the weather, it has adjustable windows; these windows can be opened or closed according to the weather conditions. This house is considered by many poultrymen to be one of the best styles that has been introduced.

The fourth house is one of the extremely airy ones, being made of boards that are dressed on one side and the cracks battened; about half of the front is open to the weather, but may be closed in on stormy days by large doors. There is not any special protection for the roost; the chickens roosting in this house in exactly the same temperature as they worked during the day. This house, needless to mention, is much cheaper than the other styles.

We hope to experiment with these houses long enough to be able to give definite information as to which is the most favorable for the production of eggs in winter, also in which house the fowls consume the least feed. We hope also to have sufficient data to state whether the fresh-air houses are more conducive of good health and the production of eggs which hatch large numbers of strong chickens, or whether the warm house is equally as good.

An Experiment to Force Fowls to Moult.

It has been claimed by some poultrymen that old birds can, by certain methods of feeding, be forced to moult early in the season and would thereby have a full new coat of plumage by October 1st, and would be ready to begin to lay when eggs are scarce.

Three pens of birds were selected with the idea of forcing them to moult if possible. Two breeds of chickens were represented in these pens—White Wyandottes and Barred Plymouth Rocks. Two of the flocks were housed in House No. 1 in the regular breeding pens to which is attached a small grass yard about 14 ft. wide and 80 ft. long. The other pen had practically free range.

The experiment was started the first week in July. The birds were fed less than one-third of the usual quantity of feed; the object being to stop egg production. This method of feeding was continued for two weeks, after which the birds were fed in the best possible manner known. It is claimed that by using a half or less of the usual feed for about two weeks the birds stop laying, after which if the usual quantity of feed is given, they will, in most cases, begin to moult.

In this experiment with the two pens which were confined to small runs, fully 75 per cent. of the hens began to moult the third week of the test. The other 25 per cent. began to lay fairly freely when the heavy feeding had been in progress about a week. The birds that had free range stopped laying but did not commence to moult. When the feed was lessened they simply ranged farther, and, as far as outward appearance was concerned the amount of feed gathered was used in maintaining the body in normal condition, practically no eggs being produced. When the heavy feeding was commenced, they began to lay fairly well, but showed no inclination to moult. In fact these birds were among the last to moult this year.

This experiment would seem to indicate that it is possible to control the moulting season more or less. It might be that the first week in July is a little early to undertake work of this kind. A few of the hens that moulted first began laying in September and moulted a second time in November. This, of course, is a very serious objection. Whether there is anything to be gained by forcing the hens to moult early in the season would depend entirely upon local conditions such as to markets and so forth. If eggs were as high as they have been this season, it is extremely doubtful if it would pay better to have hens moult than to have them produce eggs.

Cold House.

In the report of 1903 there was an account given of the use of a cold house. It might be interesting to add that the birds in this house in the extreme cold weather of 1903 and 1904 gave very satisfactory results. None of the females in the house had their combs frosted. This seems somewhat remarkable when it is remembered that there were some Single Combed Leghorns in the pen. Of course the male birds of this variety would freeze their combs very easily; the females seem to be able to stand considerable cold. The temperature in this house registered as low as 10 degrees below zero upon

one occasion only; the temperature went to zero upon half a dozen different occasions. The birds did not produce as many eggs as in the previous season, but still they laid a fair number. We will be able to test this manner of housing much more satisfactorily in the new houses that have been constructed during the year.

General Treatment of Breeding Stock.

The system followed in 1904 is much the same as in 1902 and 1903. We have as yet no reason to change our opinion in regard to airing the houses freely during all seasons of the year. We have found that birds, even of the Leghorn type, will stand much more cold than we had anticipated; that is to say, where they have been kept in moderately cold houses at all seasons of the year. We have also had the experience that the bringing of a bird from a warm house to a cold house is a very bad plan, as the combs and wattles of such birds are easily frozen. Our system of leaving the doors open the greater part of the day is not favorable to the production of eggs in winter from Leghorns, Minorcas and such birds, but is better adapted for Plymouth Rocks, Wyandottes, etc. The usual method of feeding has been followed, and need not be discussed here.

New Breeds of Fowls Added During the Year.

Eggs of the following varieties were purchased during the season: Black Orpington, White Orpington, Jubilee Orpington, Salmon Faverolle, and Brown Favorelle. From these eggs a fair percentage of chickens were hatched. The White Orpingtons and Black Orpingtons hatched a much higher percentage of cockerels than pullets, and unless we can see our way clear to buy females of these breeds, we will not be in a position to maintain a breeding pen of either variety.

As regards growth, the Salmon Favorelle proved to be a rapid flesh forming chicken. As yet we know nothing about their egg production. I am doubtful if they will ever become a popular fowl with the poultry fancier. They might be described as resembling the Houdans, Dorkings, and Brahmas. These three breeds when mixed together certainly do not produce a handsome fowl.

The Jubilee Orpingtons grow very rapidly, and are completely feathered when 39 days old. From general appearances they would make a fairly good chicken for broiler purposes. In early maturity for the production of eggs they have proved themselves to be better than Rocks, Wyandottes, or other Orpington varieties. They did not grow nearly as fast in proportion after ten weeks of age as they did during the first ten weeks of their lives.

We have also added a pen of Rose Comb Brown Leghorns and a pen of Black Hamburgs.

Geese.

Two varieties of geese have been added to the poultry department. These have been added for the purpose of better instruction to students. In another year we may be able to do a little experimental work with them. Many poultrymen in Ontario seem to think that we will find it rather difficult to get the geese to breed where they have no access to a pond or stream. Next year we will be able to report whether or not we succeeded in getting the geese to breed satisfactorily.

Experiments in Fattening Chickens.

Early in August a grain-sprouting machine was purchased. The manufacturers of this machine claimed that it would make a saving in the feed used and would be profitable for the average farmer to buy. We have experimented with a fairly large number of chickens during the fall, but as yet have not sufficient data to warrant publication. We found considerable difficulty in getting rations that were palatable. For example, a ration made of equal parts of oats, buckwheat, and barley meal when ground makes a fairly palatable ration. These grains when sprouted do not make nearly as good a ration owing to the fact that the chickens in nearly every instance refuse to eat the buckwheat, unless practically starved to do so, in which case little or no gain is made. It will be seen from this that we lost considerable time in finding rations that were palatable. We have found that a ration of equal parts of wheat, oats, and buckwheat works fairly well, both as ground grain and sprouted grain.

We have commenced an experiment with thirty birds which is to extend over one year's time, with the idea of testing sprouted grain, whole grain, and a mixture of sprouted grain and ground grain as feeds for laying hens.

I might add that the sprouted feed is relished by all classes of chickens, and I consider that oats when sprouted are a very palatable feed; in fact, we have experienced no difficulty whatever in getting fowls to eat large quantities of sprouted oats or barley. Sometimes these grains are not very palatable when dry. Wheat is somewhat high-priced at the present time; therefore if we can make oats palatable it will save considerable in the cost of feeding fowls. The sprouted grain also acts more or less as a green food.

This year we followed along much the same lines as last year in regard to testing substitutes for skim-milk in fattening rations. The results of these experiments are given below. The grain ration consisted of equal parts of barley meal, oatmeal, and buckwheat meal. In the skim-milk ration an equal amount of milk was mixed with the grain, or in some cases a little larger amount. With the skim-milk substitutes, 15 per cent. of the ration was made of the substitute used. We have calculated that the grain ration cost $1.25 per cwt.; the skim-milk 10 cents per cwt.; beef scrap, $3.25 per cwt.; animal meal, $2.00 per cwt.; and blood meal, $2.75 per cwt.

Ration.	No. of Birds.	Weight at beginning of experiment.	Pounds of gain in two weeks.	Pounds of grain consumed.	Cost of grain.	Pounds of grain to make one pound of gain.	Pounds of milk consumed.	Cost of milk at 10c. cwt.	Pounds of skim-milk substitute.	Cost of substitute.	Total cost.	Cost of one pound gain.
Grain	12	58	10	47	58	4.7	50	5	.....	.....	63	6.3
and Milk	12	35	16.5	47.75	60—	2.9	50	5	.....	.....	65	
Grain	12	55	9	47	58+	5.22	.....	.....	7	14	72	8
and Animal Meal	12	43	12	48	60	4	.....	.....	7	14	74	6.16
Grain	12	57	11	47	58	4.27	.....	.....	7	22	80	7.27
and Beef Scrap	12	40	15.5	48	60	3.04	.....	.....	7	22	82	5.9
Grain and Blood Meal	12	54	12	47	58	3.9+	.....	.....	7	19	77	6.4

Remarks.

From the table it would appear that skim-milk produces a pound of gain cheaper than any of the other rations. The animal meal ration this year did not do nearly so well as last season, and the blood meal ration did better. Last year we had considerable difficulty in getting the birds to eat the blood meal ration, but this year they relished the ration as well as any of the other rations used. The beef scrap makes a good ration, but, as stated in last year's report,, is too expensive. It will be noticed that in the two tests given, the amount of gain and also the cost of a pound of gain varies considerably. This is largely due to the relative ages of the chickens. The chickens in the first test were of the Wyandotte breed and were practically matured, as far as growth was concerned. For this reason they would not make as great gains as if they had been put up to fatten perhaps one month earlier. The chickens in the second test were younger and were of the Orpington breed. Being immature, they both grew and put on flesh. This is an important point when buying chickens for fattening purposes. This cannot be considered a breed test. If anything, it is valuable as an indication of which is the more profitable age for fattening chickens. The results of the tests of substitutes for milk simply bear out the facts as printed in previous years, that these foods require several years of careful experiment before we can arrive at definite conclusions. It is possible that those by-products purchased at one time may be more palatable than are those of another shipment. I think this is the case with the blood meal. Some samples of blood meal appear to be much darker in color than others; also some samples appear to be relished by chickens better than others.

The blood meal and beef scrap we purchased from Swift & Co., Chicago; the animal meal from A. J. Morgan, London.

I might add that the skim-milk substitutes have a tendency to produce a yellowish cast to the flesh. Skim-milk, as has been said in previous reports, is one of the best feeds for the production of white flesh.

TESTING INDIVIDUALITY.

The following table will give some idea of the gains made by different individual birds. In selecting birds for experimental purposes, we have always endeavored to get birds as nearly alike as possible. Some types of chickens are, generally speaking, poor feeders. We selected the birds used in a test below from a flock of chickens which would be considered of fair average. Some of them would be called good type, while others were not so much so. It will be noticed that they vary in the amount of gain made, from 2 lbs. 1 oz., to 1 lb. 1 oz.

Leg Bin	Wt. Commencement.		Wt. 1st Week.		Wt. 2nd Week.		Wt. 3rd Week.		Gain.	
	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
7058	3	0	3	7	4	1	4	11	1	2
7054	3	4	4	1	4	1	4	8	1	4
7087	4	6	4	11	4	11	5	7	1	1
7372	3	15	4	14	5	3	6	0	2	1
No band.	3	0	3	10	4	3	4	10	1	10
7355	3	13	4	13	5	4	5	13	2	..
7066	3	10	4	2	4	10	4	11	1	1
7091	3	7	4	2	4	9	5	0	1	9
7082	3	15	4	9	5	0	5	2	1	3
7078	3	10	4	4	4	10	5	0	1	6
7064	4	0	4	14	4	14	5	11	1	11
7063	3	1	3	9	4	3	5	0	1	15

Respectfully submitted,

W. R. GRAHAM.

PART XV.

THE LECTURER ON APICULTURE.

To the President of the Ontario Agricultural College:

SIR,—I have the honor of presenting herewith my fifth Annual Report in the department of Apiculture.

The usual course of eighteen lectures was given in the fall term.

During the last two years I have been trying to discover the very cheapest and most profitable method of storing extracted honey. When a large amount of honey is to be stored it is found that the sixty-pound cans, generally used represent a large outlay, and unless sold quickly generally become delapidated. Large tanks, such as are used for water, vinegar or pickles are expensive, and very much more so when they leak. Oak barrels are costly, and if graulated honey is taken out of them it costs nearly as much to cooper a barrel together again as to buy a new one. I have been using rectangular tanks made of flooring (see Report for 1903), the ends and sides of which could be removed after the contents had graulated. Although they were well waxed they sometimes leaked at the corners.

This year, I tried, with entire success, lining these tanks with manilla paper painted with hot paraffin wax. I experimented with dry goods packing cases lined with waxed manilla paper, and found these boxes absolutely proof against leaking.

To store honey in this way, a box must be used, the interior of which is free from any projections which would cut the paper when pressed against the sides of the box. Then a full sheet of manilla paper is laid on the bottom of the box (completely covering it), and another sheet around the interior sides. Where the two ends of this sheet meet in one corner is nailed a carpet strip so as to cover both ends of the paper, and other pieces of carpet strip join the edges of the sheet on the interior sides to the one on the bottom. Manilla paper can be bought in sheets of any length and thirty-six or forty-two inches wide. Then the paper and carpet strips are painted over with hot wax, and wherever the paper is accidentally torn a small piece of shingle is nailed over the break and then covered with wax. This box makes the very cheapest means for storing extracted honey and one that is perfectly safe.

Nearly all bee-keepers strain their extracted honey through cheese cloth. This is a very slow process. The honey runs slowly, especially if it is not very warm, the cloths become clogged with minute particles of wax, and more or less honey is spilled in changing cloths. Others run their honey into tanks; and after the impurities have risen to the surface, they run the clear honey out of the bottom of the tanks. But this cannot be done unless the honey is thin, either from heat or from not being sufficiently ripened. I have made this method very reliable by using a large tin storage can placed out in the sun. The can is painted black so as to absorb heat more readily from the sun. The cover of the can is a wooden frame with glass top, sloping after the manner of a hot bed sash or solar wax extractor, and this glass is kept turned towards the sun. When the sun is strong, the honey becomes very warm, and the small particles of wax and other impurities come to the surface.

Respectfully submitted,

H. R. ROWSOM.

PART XVI.

THE LIBRARIAN.

To the President of the Ontario Agricultural College:

SIR,—As Librarian of the College, I herewith submit a brief report for 1904.

During the year, we have added 1,125 books to the Library, making the total number of bound books on our shelves 12,271. We have purchased back numbers of the following perodicals in order to complete our sets :

Farmer's Advocate, Vols. 14—18, 22.
Queen's Quarterly, Vols. 3—11.
Nature, Vols. 1—53.
Breeder's Gazette, Vols. 1—30.
Quarterly Review, Vols. 86—188.
British Bee Journal, Vols. 27—31.
Journal of Society of Chemical Industry, Vols. 1—18.
Canadian Magazine, Vols. 1—19.

The 1,125 books added to the Library during the year are classified as follows:

Economics	48	History	40
Literature	58	Hygiene	12
Geography	7	Reports	30
General Science	7	Nature Study	43
Apiculture	9	Entomology	19
Photography	83	Botany	35
Biology	17	Chemistry	58
Physics	18	Bacteriology	20
Poultry	9	Dairying	15
Veterinary	23	Horticultural Reports	7
Horticulture	53	Forestry Reports	3
Forestry	36	Agricultural Reports	60
Agriculture	89		

We desire to acknowledge and express our appreciation of all our exchanges, especially those of the United States Department of Agriculture, and the numerous Experiment Stations in America, Australia, Cape Colony, India, and Europe.

In last year's report, I mentioned that we had begun to make a card index of the publications of the Ontario Department of Agriculture. I am pleased to be able to report that Miss Rowsome has made good progress in this work, and the indexing of all the College bulletins and reports has been completed to date. This index will be extremely useful to the staff and students, as author and subject cards are written for each title, and as much information as possible has been placed upon each card so as to give the person consulting the catalogue a good idea of the manner in which the indexed article is treated. We shall continue this work and hope to have finished by the end of next year the reports of the Fruit Growers' and Dairymen's Associations.

The portrait of the late J. Hoyes Panton, for sometime Professor of Biology and Geology at this institution, and presented to the College by the ex-students, and the portrait of Dr. Mills, President of the College from 1879 to 1904, presented to the College by the graduating class of 1904, have been hung in the Reading Room and add greatly to the appearance of the room. A memorial tablet to the memory of J. H. Findlay, '92, '93, who was killed at Paadeberg, has also been placed on the wall of the Reading Room.

Miss A. G. Rowsome, B.A., has had charge of the card catalogues and general management of the stack room, and I wish to call your attention to the skilful manner in which she has epitomised and catalogued the numerous articles and subjects in the College Reports and Bulletins.

Mr. W. G. Milligan has had charge of the book delivery and periodical rooms. His duties also include the checking over and putting on file the 150 periodicals the Library receives by purchase or exchange.

I have the honor to be sir,

Your obedient servant,

F. C. HARRISON.

PART XVII.

THE PHYSICIAN.

To the President of the Ontario Agricultural College:

SIR,—I have the honor of presenting to you my eleventh annual report.

During the early months of the year we had more than the usual sickness in the College. First, there occurred on the fourth of January, an outbreak of measles amongst the students, eleven of whom contracted the disease—eight residents and three non-residents. Some of the patients were very ill, and to give them the care they needed we were obliged to secure the services of a trained nurse for a few weeks. Then, in the latter part of the month, the College was invaded by varioloid, with which four students were sent to an isolation hospital. Of these, one developed acute endo-carditis which for a time caused his physician and friends some anxiety, but the others were so slightly ill as to require little or nothing more than isolation. You will so well remember the facts of our experience at that time, and the means adopted for the suppression of the outbreak, that it will be quite unnecessary for me to give any further details. There were also during the winter months many cases of influenza, bronchitis, tonsillitis, and other ailments common in the community. Among these was a rather severe case of facial erysipelas taken to the General Hospital in this city. There were about the usual number of accidents of which I shall mention only the most serious—the crushing of a hand of one of the laundresses in a mangle. For the servants and the students who remained at the College during the summer, I had considerable work to do.

Several changes very important to the health and comfort of the students were made in the College and gymnasium during the summer vacation. I refer especially to the improvements in the swimming bath, to the clearing out of the old urinals and closets and the putting in of excellent modern sanitary conveniences, and to the fitting up of a fine large bath room, with a sufficient number of showers and tubs worthy of a place in the institution, I feel sure that every one interested is thankful for these important advances.

The College opened in September with a very large attendance. I shall not detail all the minor ailments and injuries requiring my attention thus far during the term, but must report a cast of acute pleurisy taken to the General Hospital in September where the patient remained for three weeks before he was well enough to return to his studies. I regret to have to report also a case of acute appendicitis in a student who entered the same institution for operation on the 16th of the present month. The patient though still in the hospital is making good progress toward recovery.

The opening of Macdonald Hall in September has added very largely to my duties. Though in every respect it seems a model residence for young ladies attending College, the one hundred and twenty earnest students of nature and home-making residing therein had their own share of sickness during the autumn. This was perhaps largely due to the unfinished state of the building for a good part of the term, when many suffered

from various mild respiratory diseases and one from pneumonia. I must say, however, that on the whole the health of both residences in common with that of the general public has been remarkably good this fall.

At the beginning of the session you—very wisely in my opinion—made vaccination compulsory. In the discharge of that duty I met with some who very strongly objected, and who stated that they would not have come to the College had they known vaccination would be required of them. In view of such statements, it appears to me only fair that, in future, College Announcements should contain a notice that all students must either bring with them certificates of recent successful vaccination or be vaccinated on admission.

Three times in the last nine years students in some of the departments of the College have been taken ill with smallpox. In my opinion the time has arrived when, in the interests of the institution, an isolation hospital should be built.

Respectfully yours,

W. O. STEWART.

MACDONALD INSTITUTE.

PART I.

THE DEPARTMENT OF HOME ECONOMICS.

To the President of the Ontario Agricultural College:

SIR,—I have the honor to submit herewith my report on work of 1903 and 1904 in the Home Economics department.

EQUIPMENT.

The Department of Home Economics was opened in September, 1903, three months before any part of the Macdonald Institute building was ready for use, and a year before Macdonald Hall was ready for occupation. During the first term the classes were held in rooms of the Chemical Building and the Massey Library. In January, 1904, the classes were moved into the eastern wing of the Macdonald Institute, and the lectures and practical classes were fairly well carried on in spite of many disadvantages resultant from the unfinished state of the building. When the new school year opened in September, 1904, the building was nearly completed, and there are now a sufficient number of rooms adequately equipped for present needs.

The entire second floor of the Macdonald Institute is devoted to the Home Economics work, and consists of two class-room kitchens, one practice kitchen, one pantry, one stock room, two cold-storage rooms, one class dining-room, one large lecture room, one dress-making room, one sewing room, one fitting room, one laundry class room, four office bedrooms, two locker rooms, janitor's room, various cupboards, and a small apartment containing two bedrooms, bathroom, living-room, pantry, store-room and kitchen. In addition, this department shares with the Nature Study and Manual Training departments the privileges of the assembly hall, reception room, reading room, and reference library.

COURSES OF STUDY.

1. *The Normal Course.* This is especially designed to prepare Domestic Science teachers for our public schools, and is a continuation of the work which was carried on in the Ontario Normal School of Domestic Science and Art in Hamilton. It occupies two years; the first year is devoted chiefly to subject matter, and the second chiefly to methods of teaching the subject. The Public School Board of Guelph provides the Institute with four classes of girls, which gives the Senior Normal students excellent practice in teaching.

Following is the outline of the course as given in this year's Announcement:

Junior Year.

Lesson periods are of fifty minutes each.

Elementary Chemistry	2	periods weekly.
Physiology and Hygiene	1	period "
Foods	1	" "
The House	1	" "
Elementary Cooking	6	periods "
Psychology	2	" for one term.
History of Education	2	" " "
General Methods of Teaching	2	" " "
Elementary Economics	2	" " "
Biology	1	period " "
Practice Work	6	periods.
Elective	3	"

Junior Year.

Chemistry of Food	6	periods.
Advanced Cookery	3	" for two terms.
Bacteriology	3	" " one term.
School Laundry	2	"
Marketing	1	period.
D. S. Methods	1	"
Observation	1	"
Practice Teaching	3	periods.
Physiology and Hygiene	1	period for one term.
Home Nursing and Emergencies	1	" " two terms.
Ethics of the Home	1	" " one term.
Elective	6	periods.

The course was opened in December, 1903, with five students in the Senior Class, and nine in the Junior Class. At present we have twenty students in the Senior and seventeen in the Junior Class.

2. *The Two Year Housekeeper Course.* This occupies two years, and was designed for those girls who wished to study the subject of Home Economics with a view to housekeeping in their own homes. The first year work was very similar to that of the Junior Normal Class, but the second year is devoted chiefly to practice in the various branches of housework and housekeeping. Each student in this class is required to act for at least a week as working housekeeper in the department. She is required to keep all rooms in order, to do all necessary marketing, cooking and serving for two people who live in the apartment, and finally to render an itemized account of the money placed at her disposal.

The following is an outline of the course as given in last year's Announcement:

I.—Two Years Course in Domestic Science.

Subjects:

Foods,
Cooking,
Physiology and Hygiene,
Dietetics,
The House,
Marketing,
Home Nursing and Emergencies,
School Sewing,
Laundry Work,
Chemistry,
Elementary Biology,
Bacteriology,
Physical Training,
Psychology,
Child Study,
Ethics of the Home,
Economics,
History of Education,
Methods in Domestic Science.

The course was opened in September, 1903, with ten students, of whom five are continuing the second year work. This course was not offered in this year's Announcement, as it was judged desirable to replace it with a shorter course for the present.

3. *The One-Year Housekeeper Course.* This occupies one year, and replaces the two year course. It retains the practical work of the old course, including the Apartment housekeeping.

Following is an outline of the course as given in this year's Announcement:

The House	1	period weekly.
Physiology and Hygiene	1	" "
Foods	1	" "
Plain Sewing		
Machine Sewing		
Making of Shirt Waists	4	periods "
Cookery	6	" "
Dietetics	1	period for one term.
Sanitation and Hygiene	1	" " "
House Furnishing	1	" " "
Home Nursing and Emergencies	1	" " two terms.
Laundry	1	" " one term.
Practice	9	periods weekly.
Marketing	1	period for one term.

The course opened in September, 1904, with sixteen students.

4. *The Professional Housekeeping Course.* This course occupies two years, and is designed to train skilled housekeepers. The first year is devoted to general training in the work of an ordinary house; the second to study of the special problems of the professional housekeeper, together with a great deal of actual practice work in the different branches of service in Macdonald Hall.

The course was opened in September, 1904, with four students. These are obtaining their general training along with the Junior Normals and Housekeeper students. Their second year work will be governed largely by the work which they accomplish this year, and is not yet definitely outlined. Only those who give evidence of real executive ability will be permitted to continue, and the diploma will not be granted until each candidate has proven that her professional work is satisfactory.

5. *The Short Course in Domestic Science.* This course is designed especially for those who cannot spend more than one term at the Institute. It provides training chiefly in the practical work of plain cookery, laundry and plain sewing, with simple lectures on food, sanitation, and home nursing, but is thorough as far as it goes. No examinations are held in connection with this course, but regular attendance is demanded.

The first class opened in January, 1904, with fourteen students; the second in April with seventeen students; the third in September with fifteen students. The course is proving popular, as evidenced by the thirty-two students who have been entered for the first term of 1905.

6. *Optional Courses.* These are courses offered to those who do not wish to take full regular courses, or who wish to take a group of subjects fitted to their special needs. There are several subjects offered only as optional, but many of the regular courses may be chosen when there are

vacancies in the classes. Several students this year are taking optional courses in the hope of a vacancy occurring in the One Year Housekeeper course.

Following are the chief optional subjects in the order of their popularity:

Shirt-waist Making—in which the students are taught to cut, fit, and make shirt-waists.

Dressmaking—in which the students are taught to draft their dress patterns; to cut, fit, and make plain dress; and finally to make more elaborate dresses, suitable to the wearer in design and color.

Millinery—in which the students are taught to make folds and bows, and to trim simple hats; to renovate old hats and trimmings, and to make and cover wire shapes.

Machine Sewing—in which the students are taught to use a sewing machine, and the making of white underwear.

Wood-carving—given in the manual training department

Laundry—in which the students are taught the making of soap, treatment of hard and soft water, and the laundering of flannels, bed-linen, body-linen, napery, silk, lace, etc.

Horticulture—twelve lessons given in the Horticultural department.

Poultry Raising—twelve lessons given in the Poultry department.

Home Dairying—twelve lessons given in Dairy department.

There has been little demand for the last three subjects owing to the superior attractions of the various sewing classes, but we believe they will become popular as the nature of the work becomes better known. There are at present twenty-three optional students.

Recipients of Teachers' Diplomas in Domestic Science, 1904.

Miss Enid Robertson, ... Perth, Ont.
Miss Isabelle Wright Strong ... ... Hamilton, Ont.
Miss Ella L. Miles ... ... Hamilton, Ont.
Miss Elizabeth MacVannel ... ... St. Marys, Ont.

Women's Institute Convention.

Two conventions of the Women's Institute have been held in Macdonald Institute—the first in December, 1903, in the midst of building operations, with an attendance of 200 delegates, and the latter in December, 1904, with an attendance of 300 delegates. Both of these conventions were addressed by different members of our staff.

Summary of Attendance.

Enrolled for the year ending June, 1904.

Senior Normal Class	5
Junior Normal Class	9
Two Year Housekeeper Class	10
Short Course in Domestic Science Class	31
Optional Class	13
Guelph Public School Classes	86

Enrolled to date for the year ending June, 1905.

Senior Normal Class	20
Junior Normal Class	17
Professional Housekeeper Class	4
Two Year Housekeeper Class	5
One Year Housekeeper Class	16
Short Course in Domestic Science Class	15
Optional Class	23
Guelph Public School Classes	91

Conclusion.

The experience of the past year shows that the townspeople are already, and the country people are rapidly, coming to appreciate the training in household affairs which is offered by the College. It remains for us, therefore, to provide the teachers which are necessary to make the most of our present equipment, and do for the girls of the country what the College is already doing for the boys.

Respectfully submitted,

MARY URIE WATSON.

PART II.

THE DIRECTOR OF MANUAL TRAINING.

To the President of the Ontario Agricultural College:

SIR,—I have the honor to submit to you my first annual report on Manual Training as carried on in connection with the Ontario Agricultural College.

The Manual Training movement owes its inception to the ex-President, Dr. Mills. In January, 1902, Sir Wm. C. Macdonald, of Montreal, through the instrumentality of Dr. Robertson as the administrator of funds, offered to the Premier of the Province of Ontario assistance to carry out a scheme for the betterment of education at rural schools. Dr. Mills made an application to Sir William for assistance towards establishing at Guelph courses of instruction in Manual Training, Nature Study, and Domestic Science.

Early in January, 1903, an equipment to accommodate twenty students in Manual Training was sent from Ottawa. This was temporarily installed in a part of the Museum, on the ground floor of the Biological Building, where eighty-two students received instruction. In the Fall term of 1903 there was no instruction given at the College. The equipment was taken over by the Guelph Board of Education, and classes for the pupils and teachers of the Public Schools were inaugurated under my charge. With the opening of the Macdonald Institute in the Winter term of 1904 the Manual Training department was fitted with an entirely new equipment, and seventy-eight Agricultural students attended the course. Concurrently with these classes a course in wood-carving was carried on, with nine students in attendance. The Spring term opened with seven wood-carving, two regular, and three Saturday morning Manual Training students. On May 30th a special Summer Course in Manual Training, attended by twenty teacher-students, was commenced and continued until July 29th. The Fall term of 1904, which is about to close, has been a particularly heavy one, with six Manual Training, thirty-four Nature Study, and ten Wood-carving students. The work of this department is now dominated by five distinct aims:

1. A course for Agricultural students.
2. An optional course in Wood-carving for Domestic Science students, and others.
3. Consolidated School course.
4. A correlated course for Nature students.
5. A Normal course.

1. THE AGRICULTURAL STUDENTS.

Considerable changes in the course usually followed was found necessary to meet the special needs and demands of agricultural students without losing or destroying the pedagogical value of the instruction. The whole course was planned and pursued on educational lines; the object being not so much the production of matrial results in the shape of models, as to inculcate habits of accuracy, neatness, and thoroughness through processes pedagogically and technically sound, for whether, and to what degree culture is educative depends materially upon the process of attaining it. There are many mechanical employments, even when pedagogically pursued, of comparatively little educational value, and when not carried out along educational lines are mechanical and stupifying.

If the training of the hand is utilized to influence the mind and moral character of our students, mechanical action must be avoided, at least in the training of our first year students, leaving the acquisition of technical skill

to subsequent years, because in such training of the hand, the movement being repeated again and again the mental activity becomes gradually fixed in the nerves and brain; that is, it is retained by memory until the movement can be performed as it were automatically. Such a mechanical movement is closely related to what is called reflex motion—an action executed more or less unconsciously—it is memory in action devoid of conscious thought exercising little or no influence on the brain.

In our course we sought to keep the intellect out of this abyss of habit, and to make the ethical behaviour more and more a matter of unquestioning habit, for the first machine a man makes is an education to its maker, but the second and subsequent machines made are only a matter of habit. Indeed, if all education be regarded as disciplinary, it is evident that all discipline is not educational. There are certain craft operations, certain kinds of acquired skill, which demand that a man should stop thinking and put himself as nearly as possible in the condition of a machine, and carry through a series of movements like a machine. In estimating the value of a Manual Training course, it seems to me that the beginning must be interpreted from the end, not the end from the beginning. An engineering workshop is unintelligible until we reach the room where the complete engine stands. Everything culminates in that final product, is contained in it, is explained by it. It seems advisable, therefore, that our first year course should be truly educational in its character, allowing it to assume in each succeeding year a somewhat more technical nature.

A Nature Study Class preparing Garden Plots.

The present state of the labor market is a problem which, in the very near future, is destined to wholly change farming conditions and operations. The scarcity of hand labor will encourage the increase of labor saving devices. The greater use of complicated machinery and implements in the various branches of agriculture will demand dexterity of hand as well as of brain power to manage them, and in these days of competition the capacity for handling tools linked to a keen ability for understanding mechanical principles and machinery is vastly more important to a farmer than the mere acquisition of the facts. There is much economic waste going on from day to day on the average farm, and the farmer who is capable of effecting small

temporary repairs to machinery and implements in the height of a busy season, and looking after them properly when the season is over, is the one who will successfully contend with aggressive competition. But the workshop may be made an introduction to a less popular virtue than money making. A place for everything, and everything in its place; a use for everything, and everything ready for its use, is the wholesome economic philosophy of the workshop. What eye accustomed to the tidiness of a well-ordered workshop will permit the wreck of a machine for want of a bolt, or rotting for want of a coat of paint, or a shed to cover it; or to allow the fertilizing liquors of the farm yard to be wasted in enriching the weeds of the roadside ditch.

It is indeed true that a general command over the use of one's fingers is a very important element of industrial efficiency. It can of course be developed by training, but the greater part of this may be of a general character and not special to the particular occupation. Manual skill that is so specialized as to be wholly incapable of being transferred from one occupation to another is in a new country like Canada of less importance than in an older community. Putting aside the faculties of artistic perception and creation, we may say that what makes one occupation higher than another, what makes the works of one country more efficient than another, is chiefly a superiority in general sagacity and energy which is not specialized in any one trade. To be able to bear in mind many things at a time, to have everything ready when wanted, to act promptly, and show resource when things go wrong, to accommodate one's self quickly to changes in details of the work done, to have always a reserve of force which will come out in emergency, these are the qualities which make a great industrial people. Thev are not peculiar to any occupation, but are wanted in all, and to a great extent can only be acquired by training. To give our students this needed adaptability, a whole building devoted to the Manual Arts is a necessary adjunct. It should contain rooms for wood and metal work, a machinery hall, a lecture room, a drawing room, and offices. Concurrently with the systematic course of the workshop, the machinery hall would offer *unlimited manual temptations* to the boys to take the machinery to pieces and place together again, to study methods of gearing, driving, sketching and drawing the various parts—in short to be free to attempt anything they choose without following a routine course.

2. Optional Course in Wood-Carving.

Originally this course was really outside my proper function, but as there was a demand for a class in this work I consented to undertake the instruction, and this arrangement still continues notwithstanding the increase in my other duties. This branch, too, needs much in the way of special tools, designs and storeroom—the work being much larger than those of the other courses.

3. The Consolidated School.

The Consolidated School occupies my time for two lessons a week. The course required is totally different from those hitherto specified, necessitating time for consideration, thought, and preparation—time which can be ill spared from my more immediate duties at the Institute.

4. Nature Study Correlated Course.

The students attending are teachers sent by the various Provincial authorities to take a three month's course. The object of this course has been to demonstrate by means of practical work and lectures how the different subjects of the school may be correlated; how that Manual Training is not really

a subject to be taught so much as a means of teaching other subjects. Lessons were also given on construction of tools, cutting angles, method of sharpening and grinding tools, construction of the knife, plane, chisel and saw. Drawing—hard and flexible point; correct methods of handling brush and pencil; brush drawing; coloring; drawing and coloring of leaves, sprays, buds, roots, birds, insects, flowers, and sections of timber. Practical work was given in wood, clay, and cardboard.

5. Normal Course.

This course aims at giving a thorough training to teachers holding permanent professional certificates desiring to qualify as Manual Training Instructors.

Subjects of study.

Paper-folding. Cutting, tearing, mounting, designing, and coloring.

Clay-modelling. Manipulation of clay, clay cutting and carving, storage and tempering; modelling of type forms, natural objects, casting.

Rattan and Raffia work. Basketry, weaving.

Cardboard work. In thin and thick board.

Practical woodworking. Construction and constructive design.

Drawing. Freehand sketches, working drawings, plane and solid geometry, elements of design.

Tools. Construction of, their use, care and sharpening, analysis of the action of cutting tools.

Theory and History of Educational handwork.

Organization. Equipment, methods, materials, cost, etc.

Thesis on a given subject.

Machine Shop Practice. Tools, templets, lining out, chipping, filing, drilling, drifting, methods of union, etc.

Lathe Work. Turning in soft and hard woods, tools and tool angles, chucks and chucking, boring, slide rest turning, screw cutting, etc.

Forge Work. Tools, cutting, breaking, hammering, care of fire, pointing, bending, sharpening, drawing, punching, twisting, flattening, welding, upsetting, hardening, and tempering.

Sheet Metal Working. Jointing, rivetting, soldering, soldering-iron, Bunsen burner, blowpipe, brazing, etc.

The Metal working and Machine shop Practice part of the course have not been carried out owing to want of provision and accommodation.

Of the twenty student-teachers who took the special Summer Course fourteen sat for examination, and an interim Certificate issued to the successful candidates for the following subjects:

Practical Woodworking.
Plane and Solid Geometry.
Drafting—Working Drawings.
Construction and constructive design.
Tools—Construction, care, use and sharpening of.
Timber—Structure, growth, diseases, seasoning, etc., of.
Theory and Practice of Manual Training.
Thesis on a given subject.

Successful Candidates.

Brennan, J., Toronto.
Chapman, F., London.
Clarke, R. W., Ballyduff.
Kirk, W. F., Toronto.
Painter, A. J., Jordan.
Shorthill, R. N., Guelph.

Coleridge, F. K., Guelph.
Faw, E., Toronto.
Jackson V. W., Fullarton.
Stuart, C. H., Ancaster.
Tuck, J. R., Mosboro.
Wilcox A. E., Stoney Creek.
Winchester, H., Ottawa.

Through the kindness of the Board of Education of the City of Guelph, our students were given opportunity for practice, criticism lessons, and observation work in the Manual Training room at the Central School, so ably conducted by Miss Rose. I herewith tender them my sincerest thanks for the facilities offered and Miss Rose for her kind and generous help.

The work of this course has been very much hampered owing to lack of racks for tools in the woodworking room, diagrams, specimen courses of models, illustrative charts, cases for finished work, storage accommodation for clay, cardboard, and primary work material.

This department should be such as will afford the highest facilities for securing professional training in all branches of the work if we are to meet the demands of the Educational Department.

I cannot close this report without expressing my sincere gratitude for the invaluable assistance and cordial sympathy I always received from the late Dr. Muldrew.

In conclusion, I beg to thank Dr. Mills, the ex-president, and yourself for the generous help afforded me, and to bespeak earnest consideration for the recommendations I have made.

I have the honor to be, Sir,

Your obedient servant,

JOHN EVANS.

A Nature Study Class on a Geological excursion.

Macdonald Hall, Guelph, Ont.

PART III.

THE ACTING DIRECTOR OF NATURE-STUDY.

To the President of the Ontario Agricultural College:

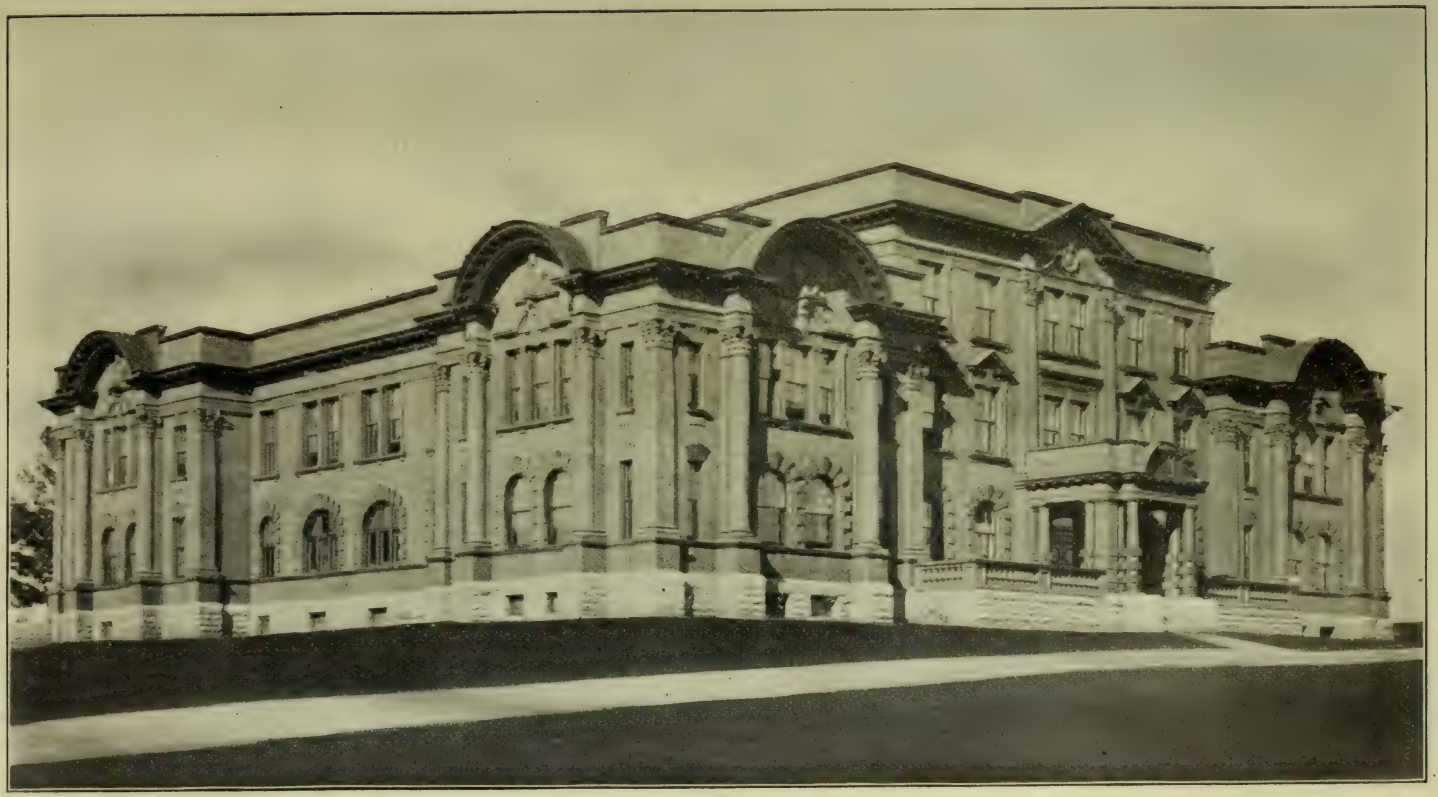
SIR,—At your request I submit this first Report of the Nature Study department of the Macdonald Institute. The report will deal with the progress of the department from its inception to the end of 1904; with the classes which received instruction; with the courses of instruction, and with the plans which the late Dr. Muldrew, Dean of the Institute, had in mind for carrying out the wishes of the generous founder, Sir William Macdonald.

THE DEATH OF DR. MULDREW.

On the afternoon of October 7th the community was shocked by the news of the sudden death of Dr. W. H. Muldrew, Dean of the Macdonald Institute. He was but thirty-seven years of age, and had just entered upon his second year of service at the Institute. He had won a high place in the estimation of his fellow-teachers of the Province by many years of successful teaching in both public and high schools. He had been given the highest honor in Pedagogics (the degree of Doctor of Pedagogy) the University of Toronto could bestow. He was rearing for himself an abiding monument in the Macdonald Institute, whose work and organization is in a large measure the expression of his strong personality.

Dr. Muldrew was a man of broad and generous sympathies. He possessed a strong, self-reliance which kept him ever buoyant and hopeful. His large, generous, open heart soon won him the confidence of his associates and his pupils, upon whom he exerted a potent and beneficial influence. His views on educational matters were always up-to-date, clear-cut, and essentially practical, as his plans for the new Nature Study movement show. His death must be considered a great loss to the cause of education in the Province.

The late Dr. Muldrew was born on the 25th July, 1867, in Hope Township, County of Durham, and spent his early years on the farm—the very best training ground for youth. Fond of outdoor life, he grew up sturdy, strong, and athletic. On the farm he formed that acquaintance with Nature which gave the bias to his life's work. He attended the High School at Port Hope, and there secured his teacher's certificate. He taught in a rural public school for a few years near Rice Lake, then studied at Woodstock Collegiate Institute for a short time, where he secured his first-class certificate. He then attended the Training Institute for High School Teachers in Owen Sound. His first High School experience was gained at Madoc High School, where he taught as Science Master for three years. During this time he prosecuted his college studies so well that, after an attendance of less than half a year at Queen's, he was able to take his degree of B.A., with honors in mathematics. His next position, in 1894, was as Science Master in Orillia High School. In July of this same year he married Miss Jennie Rollins, of Madoc, and in October was appointed principal of Gravenhurst High School. There he remained for nine years, until invited by Dr. Mills to become Dean of the Macdonald Institute here. In May, 1899, while in Gravenhurst, he obtained the high degree of Doctor of Pedagogy from the University of Toronto.



Macdonald Institute, Guelph, Ont.

As a teacher, Dr. Muldrew was almost without an equal—calm, clear, kind, and inspiring; as an administrator and leader he was tactful and thoughtful of others; as a student he was hard-working, systematic, and logical in his work, and keenly observant ; as a friend he was true as steel, unassuming, and thoroughly unselfish.

In his home Dr. Muldrew was ideally simple in his manners. It was there that he was to be seen at his best. His children were his most intimate friends and companions in the leisure hours when he was free from the duties of his profession.

I.—The Courses in Nature Study.

One of the conditions attached to Sir William Macdonald's generous gift of the Macdonald Institute and the Macdonald Hall to the Province of Ontario at the Ontario Agricultural College, as seen in Prof. J. W. Robertson's letter and memorandum of Jan. 6th, 1902, to the Premier of Ontario, was that "Courses of study and training in Nature Study should be provided for teachers in rural schools, who desire to qualify themselves in these newer subjects and methods of education."

Sir William Macdonald in the Memorandum outlined his view of the importance of Nature-Study and School Gardens in rural schools as follows:

"(1) It would certainly be of great benefit to the children at any rural school if a school garden containing plots for every child above the age of eight or nine years could be provided. Those plots would be used (like slates of large size) to put "things' on, to be rubbed off when they had served their educational purpose. The gardens could be used, as they are at a few schools in England, and as they are at many schools on the continent of Europe, for the training of children to habits of close observation, of thoughtfulness, and of carefulness.

"(2) If one may mention a method which would seem to include the best, it would be that of tracing results back to their causes, until that habit of mind is formed in the children. When a child does anything with its own hands, such as planting a seed, pulling up a plant, making examination of the changes which have taken place during its growth, making a drawing of it, mounting it and putting its name on it, he receives impressions by the sense of touch, he sees, he hears the noise of the movements he makes, and he smells the soil and the part of the plant with which he is dealing. Those impressions are definite and lasting, they add to the sum of sensuous knowledge, they prepare for the preception of logical knowledge, in a common-sense way.

"(3) For instance, if a child should plant ten grains of wheat in a row, ten grains of Indian corn in another row, ten sets of potatoes in another row, and ten clover seeds in another row; if he should pull one each of these plants every week, and find out for himself, under the guidance of a competent teacher, what had taken place in the meantime; if, further, he should make drawings of the plants and a written statement of the progress of growth, as he was able to observe it, from week to week, such a course, occupying half a day per week, would certainly give a boy or girl a great amount of exceedingly useful information, and also habits of investigation, observation, comparison, and thoughtfulness, which are immensely desirable. These would quicken the intelligence of the children, and lead them to have both desire and capacity for living happily amid rural surroundings."

In the Notes appended to the condition given above the reasons for and advantages of such courses were stated as follows:

"(1) To make possible such additions and changes in rural schools as have been indicated, and to let them be capable of anything like general adoption and extension, there is need for further preparation of the teachers. No doubt teachers in Canada would be willing to qualify themselves for this better sort of work, if an opportunity were provided. It seems desirable and practicable to give such teachers the opportunity which they need.

"(2) At several places in England, in 1901, short courses of instruction and training in methods were provided for periods of only three weeks, with the expectation of doing a good deal towards qualifying teachers to carry on their work in a better way. In Canada, it might be possible to arrange for courses of training for thirty teachers at one place, each course to last for two or three months. During this course the teachers would carry on Nature Study work as they expected the children to do it at the school afterwards. A plant-growing house for Nature-Study work would not be so costly for construction and maintenance that it would be a very difficult accommodation to have, for the winter and spring months when outdoor work would not be practicable.

"(3) If provision should be made for a class of about thirty teachers at each short course, it is hoped that the government of each Province concerned would arrange (by providing a substitute or otherwise) to enable approved teachers in rural schools to take the short course without loss of situation or loss of salary.

"(4) For a period of three years, at least fifteen teachers of rural schools outside the Province of Ontario are to be eligible to receive instruction and training in each short course without any fees.

"(5) For the first year, it is proposed to make, (*a*) an allowance at the rate of five cents per mile for the actual distance from the teacher's school to the Ontario Agricultural College, to help in meeting travelling expenses, and (*b*) an allowance of $25 to help in meeting the expenses of board and lodging, to every approved teacher who has taken a full course satisfactorily."

In accordance with the agreement, early in 1903 courses of study were outlined and printed in the Provisional Announcement of the Macdonald Institute. These were:

1. Two Years' Normal Course. Teachers' or Specialists' Certificate—September to June.
2. Three months' Course. For Actual Teachers.—Certificate.

Teachers' Normal Course of One Year.

An advanced course extending over a full College year is given to teachers who wish to qualify as specialists in this department. Only teachers holding permanent Professional Certificates are eligible for entrance. The aim is to provide instructors fitted to carry on the work of Nature-Study and School Gardens in a group of Rural Schools, in a large Consolidated School, or in an Agricultural High School.

Courses of Study and Practice.

The work will be selected from the following outlines as modified by natural conditions and the needs of the various classes.

School gardens will receive much attention, and other topics will be dealt with very largely in relation to these.

Outlines of Nature Studies.

Teachers' Courses of three months or one College year:

Fall Term:—

1. *School Gardens.* Planning and keeping of school garden plots, keeping of garden records, studies of growths in different plants, control of weeds, insects, etc.

2. *Agriculture.* Field experiments as in Experimental department.

3. *Botany.* Laboratory work and lectures, excursions for the study of the ecology of plants, with special reference to trees, fruits, seeds, and weeds, collections.

4. *Zoology.* Excursions for the study of the ecology of animals, especially birds. Collections of insects.

5. *Geography.* Study of the surface of the land, an introduction to geography and geology.

6. *Geology.* Excursions for the study of soils, rocks, minerals, and land forms.

7. *Astronomy.* Elementary work. Movements of heavenly bodies, constellations.

8. *Special Problems.* Hibernation of insects; formation of cocoons; distribution of seeds; migration of birds, etc.

9. *Conferences.* For discussion of methods and specific subjects, mainly by students in presence of teachers.

10. *Nature in Literature.* Reading and discussion of literature dealing with various phases of nature.

11. *Manual Training.* Elementary exercises in drawing, cardboard work, clay modelling, basketry, and woodwork; use of knife and simple tools; series of models for ungraded schools.

12. *Methods of Teaching.* Lectures with practice and criticism in the Institute and in the Macdonald Consolidated School.

Winter Term:—

1. *School Gardens.* Planning of plots, testing of seeds, bulbs, etc.

2. *Agriculture.* Study of live stock and poultry.

3. *Botany.* Lectures, with as much practical work as possible in greenhouses and plant-rooms of Institute.

4. *Zoology.* Domestic animals; anatomy of certain types, simple physiology.

5. *Special Problems.* Study of winter buds, insect life, etc.

6. *Physics.* Laboratory practice and lectures in elementary physics; study of the soils.

7. *Chemistry.* Laboratory work and lectures; simple experiments for ungraded schools.

8. *Bacteriology.* Laboratory practice in elementary work.

Conferences, as in Fall Terms.

Nature in Literature, as in Fall Term.

Manual Training, as in Fall Term.

Methods of Teaching, as in Fall Term.

SPRING TERM:—

1. *School Gardens.* As in Fall and Winter Term, with special attention to vegetables and fruits of early summer.
2. *Agriculture.* Experimental plots and farm crops.
3. *Botany.* Ecology of buds, spurs, etc., study of trees, identification of flowering plants, grasses, weeds, ferns, etc., collections.
4. *Zoology.* Ecology of insects, excursions for study of birds, animals, pond life, collections.
5. *Geology* (Elementary). Operation of dynamic agencies.
6. *Special Problems.* Development of frog, stages of currant sawfly, etc., relation of insects to plants, value of birds, toads, etc., to the garden and the farm.

Conferences, as in Fall Term.
Nature in Literature, as in Fall Term.
Manual Training, as in Fall Term.
Methods of Teaching, as in Fall Term.

In August, 1903, Dr. W. H. Muldrew, Principal of the Gravenhurst High School, was appointed Dean of the Institute and Director of the Nature-Study Department, but on account of the incomplete state of the new buildings no work of a practical nature could be attempted until the Spring term of 1904. In the interval Dr. Muldrew's attention was devoted to the general organization of the different departments; to the delivery of courses of lectures to the Domestic Science Normal Class in Psychology and History of Education; a special course of lectures in Methods of Teaching, Psychology, and History of Education to an advanced Normal Class in Nature Study; and to the preparation of two bulletins, the first "A Letter to the Schools: The Macdonald Institute in its Relation to Nature Study in our Public Schools"; the second, a bulletin entitled "Hints on Making Nature Collections in Public and High Schools." ...

In the spring term of 1904, an afternoon Nature Study excursion was taken weekly by those students in Domestic Science who wished to become familiar with the common plants and birds.

The Summer Class. As a large number of teachers were anxious to attend a short summer class in Nature Study, Dr. Muldrew deemed it advisable to offer a month's course, in July. Thirty-seven teachers availed themselves of the course offered by Dr. Muldrew, Mr. Jarvis, and myself. Daily excursions were made for the study of the common birds, trees, shrubs, wild flowers and plants, ferns, weeds, insects, rocks, etc., during which the student learned to prepare collections of value in teaching Nature Study. Following were the members of this Class:

Church, Rebecca, Toronto.
Coleridge, Frank, Guelph.
Collier, Jas. D., Charlottetown, P.E.I.
Currie, Jessie C., Toronto.
Doake, Jennie, Hamilton.
Fotheringham, Susie, Toronto.
Fyle, Carrie, Brantford.
Gillrie, Beryl, Drayton.
Givin, Helen, Guelph.
Gilfillan, James, Bowmanville.
Hallett, Lizzie, Guelph.
Hanlon, J. Raymond, Guelph.
Hastings, W. S., Walmer.
Hepburn, Jean, Leitrim.
Hutchison, Martha W., Toronto.
Irvine, Mabel, Brampton.
Jolley, Etta, Toronto.
Kaempf, Jessie, Berlin.
LeLean, Edith, Toronto.
McCann, Helen, Billings Bridge.
McDonald, John A., Hickson.
McDonald, David Arch., Braemer.
Marshall, Esther, Brampton, Ont.
McPherson, Florence, Caledonia.
McCutcheon, Georgina H., Guelph.
Macpherson, Mary C., Hamilton.

Moore, T. J., Guelph.
Nablo, Grant Hayes, Mull, Ont.
Nelson, William, Guelph.
Penfold, Maude, Guelph.
Patterson, Ida E., Guelph.
Snider, Wilbert, Guelph.
Strachan, May, Guelph.
Stiven, Fanny, Guelph.
Workman, Annie J., Orangeville.
Weatherston, Elspeth, Guelph.
Weatherston, Jeanne B., Hamilton.
Winchester, Harry, Ottawa, Ont.

The First Macdonald Nature Study Class.—This class came to us in September, according to the terms of the agreement with Sir Wm. Macdonald; five members from Prince Edward Island, six from Nova Scotia, seven from New Brunswick, five from Quebec, and ten from Ontario. In addition to these, two other teachers came in as special students, and remained with us throughout the term. Of this large class of teachers seven were gentlemen and twenty-eight ladies. The following are the names of the members of this class.

LIST OF NATURE STUDY STUDENTS, SEPTEMBER-DECEMBER, 1904.

Ackland, Lemuel, Hampshire, P.E.I.
Babbitt, Bess, Shanklin, N. B.
Blacklock, R. F., Smith's Falls, Ont.
Brennan, A. M., Old Barns, N. S.
Clarke, Annie, Bay View, P. E. I.
Crawford W. M., Debec, N. B.
Crysler, Sarah, Cobourg, Ont.
Doyle, Daniel, Wayside, Ont.
Fenton, Chas. H., Grafton, Ont.
Finlay, R. M., Lindsay, Ont.
Hall, Carrie M., Middleton, N. S.
Hayes, Maud., Bideford, P.E.I.
Holland, L. E., Georgeville, Que.
Huff, Harriett E., Rossmore, Ont.
Ingalls, Roxana A., West Brome, Que.
Kathan, Romelia A., Iron Hill, Que.
LePage, E. Mabel, Woodstock, N.B.
Lyon, Jennie E., Guelph, Ont.
Long, Tina, Charlottetown, P.E.I.
Moses, Winnifred, Belmont, N.S.
Mulherrin, Helena, Woodstock, N.B.
Noonan, Lizzie, Albany, P.E.I.
Oxner, Bertha G., Brookfield, N.S.
Palmer, E. Birchard, Cobourg, Ont.
Patch, Edna M., Brome, Que.
Prichard, Frances P., Hampton Sta.,
Robinson, W. J., Dutton, Ont.
Shanklin, Annie J., Shanklin, N.B.
Short, Louise, Salem, Ont.
Spencer, Agnes, Great Village N.S.
Spurr, Margaret C., Middletown, N.S
Taylor, Helen E., Knowlton, Que.
Toole, Wilhelmina, Tooleton, N.B.
Yeo, Chas. T., Little Britain, Ont.
Roddick, J., Guelph, Ont.

The Teachers' Normal Class of One Year.—As already mentioned, a Normal Class of three active teachers was formed by Dr. Muldrew in September, 1903. At the completion of the course in June, 1904, two members of the class, T. D. Jarvis, B.S.A., and H. S. Peart, B.S.A., passed their examinations satisfactorily and are thus entitled to the certificate.

At the beginning of the Fall Term, when the first Macdonald Class of teachers from the different Provinces came to us, the arrangement of the work was as follows:

Dr. Muldrew—Methods of Nature Study; Child Study and Psychology; Nature in Literature; Field Study in trees, birds and common animals.

Prof. Lochhead—Field Work and Lectures in Geology and Physical Geography; Elementary Astronomy; Experimental Plant Physiology and School Gardens.

T. D. Jarvis—Field Work with plants, insects, and diseases of plants; Laboratory courses in structural Botany and Entomology.

J. Evans—Manual Training and Color Work.

The death of Dr. Muldrew on October 7th, compelled a re-arrangement of the courses. Most of Dr. Muldrew's work was taken over by myself;

Prof. Hutt of the Horticultural department took charge of the School Gardens; Prof. Reynolds of the Physics department gave instructions in Meteorology and Soils; Prof. Harcourt of the Chemical department dealt with the chemistry of the soil and the plant; and Mr. A. B. Klugh took charge of the study of birds.

On the pedagogical side much attention was paid to the subject of correlation of the other subjects of the school course with Nature Study, to its true aims and values, and to the way it should be taught to give it its true value as an educative factor. The view was firmly taken that the acquisition of knowledge is of less importance to the pupil than correct habits of observation and enquiry.

The various powers of the child-mind, although present at birth, do not all develop at the same rate. Some develop rapidly, and reach their maximum early, while others grow more slowly, and are dependant for their development upon the materials furnished by the activities of the more rapidly growing powers. This knowledge of the order of growth of mental powers should be the property of every teacher, for a great educational principle is based on it, viz., *those powers that are at the time most active should be nourished and developed.* The advocates of Nature Study contend that no other method of education is so well adapted to the growing mind of the child, for it is supremely natural. The child by this method is furnished the nutrition which he can assimilate properly, and which will administer to his development. He abhors being spoon-fed and crammed. Nature Study stands for the active pupil and the suggesting teacher. In the words of Froebel: "To have found out one-fourth of the answer by his own effort is of more value and importance to the child than it is to half hear and half understand in the words of another." This is the spirit of Nature Study.

II.—Equipment for Nature Study.

The Nature Study department is well equipped with rooms for indoor study and practice. These occupy the ground floor of the west wing of the Institute, and include a reading-room, provided with some of the best periodicals relating to Nature Study; a library containing the most useful Nature Study books; a study material room or museum where objects useful in the teaching of Nature Study are kept; a practice room where a teacher may try her 'prentice hand on a small class of children; a large Nature Study laboratory and class-room; a storeroom for physical and chemical supplies; two tool rooms; a greenhouse; and a plant house (the two latter in process of erection). This year very few supplies or pieces of apparatus were purchased for Nature Study purposes, consequently there is a lack of material for indoor experiments which should be supplied as soon as possible. Geographical models and maps are sorely needed. Under the present arrangement, where the Biological department gives most of the instruction in Entomology, Botany, and Geology, the equipment of that department is at the service of the Nature Study department. The same might be said of the Physical and Chemical Departments in so far as they give instruction to the Nature students.

III.—The Relation of the Manual Training Department to Nature Study.

From the outset all the teachers-in-training spent one day a week in the Manual Training department with Mr. Evans. There they made the insect-cages, insect-boxes, terraria, card-board boxes for holding seeds, etc., which

form an essential part of the equipment of a nature student. They also had instruction in blob or brush-work, proceeding from the most elementary strokes to black-and-white sketches. The practice in color-work led up gradually from the three simple primary colors to the blending and combinations of these in the many-colored sketch.

Instruction was also given in clay-modelling, which represents a very important form of expression of the natural objects studied by the pupils.

Good teachers of Nature Study realize the importance of developing the powers of the child-mind along three lines, *observation*, *interpretation*, and *expression*. No one of these three should be neglected, for all are about equally valuable. Several forms of expression can be employed, but usually only two are to any extent used in our schools at the present time, largely on account of the absence of suitable materials. Nature probably provides the best materials for practice in such forms of expresion as *oral* and *written* language, *coloring*, *modelling*, *drawing* and *making*, etc. Some of these forms can be employed at an early stage of the child's school life, but the chief use of the newer forms of expression is to develop the *individuality* of the child, and to cultivate the habits of *clearness* and *truthfulness* at an early stage. And how can a child be more thoroughly impresed with the importance of truthful telling and careful seeing than in doing these things where his own work stands up before him as a witness to tell him whether he is right or wrong.

The New Educational movement takes cognizance of all these modes of expression, but it is essential that the teachers should know how to guide the pupil in giving expression to his ideas. Hence, the value of these phases of Manual training at the Macdonald Institute. In my judgment, the work done by the teachers in the Manual Training department will be of inestimable value in giving effectiveness to Nature Study instruction when correlated with the expressive studies of the school course.

IV.—The Relation of the Macdonald Institute to the Rural Schools.

As already stated, the object of the establishment of the Nature Study department of the Macdonald Institute was to "provide courses of study and training in Nature Study for teachers in rural schools." It was the earnest hope of the generous donor of the Institute that rural life would be enriched and made more useful and intelligent and happy by the introduction of the study of the plants, the birds, the soils, and the insects, with which the young lives come into daily contact, into the regular exercises of the schools. Upon Mr. Muldrew, as the first head of the Nature Study department, devolved the responsibility of outlining the scope of the department to carry out the wishes of the donor.

He recognized quite clearly that the function of the Institute was not performed when it gave only courses of study and training to those teachers sent from the Provinces a class of thirty-five every three months, according to the terms of the agreement with Sir Wm. Macdonald. He wanted, moreover, to get into close touch with those rural teachers who could afford neither the time nor the money to attend the Institute, so that he might help them in their difficulties. He held that "a very important duty of the Macdonald Institute will be to assist teachers in extending their knowledge of nature and their interest in the Nature Studies of their schools." In his *Letter to the Schools* Dr. Muldrew said: "Our first need is information on the subject from the teachers' standpoint. We have heard much about Nature Study from

authors and educators, but very little from the schools themselves. We know that good work is being done by many teachers, and we are anxious to know their methods and results. Earnest teachers may have met with failure in whole or in part, and we wish to know the cause. Will you help by sending us concise notes on your experiences in connection with practical Nature Studies? Write freely and in confidence; our only object is to get at the truth as to the present position of this department of work. By way of guidance we append a few suggestive questions, but these are not intended to be answered in order to exclude other aspects of the subject. Write on what interests you most.

"What has been done towards introducing real Nature Study into the schools? What is the attitude of the teachers—of the inspectors—of the trustees—of the people? What kind of work has been most satisfactory? How has it affected other studies? Have you made any collections? Have your local fairs offered prizes? Have you reference books in your school library? Have you a school garden? Have you planted trees in your grounds? Are the parents interested? What are the most serious hindrances? What is the effect on other school studies or on discipline? What objections are met with? What form of help would be most useful to you in introducing this subject?

"We invite correspondence on all such questions. The teachers and inspectors can probably help us most, but we wish to hear from all who are interested. We shall be glad to learn of success, but records of failure may be even more valuable to us. Guided by such information, we hope to be able to help you in making Nature Study an important feature of our educational system.

"We mean to publish from time to time a series of bulletins devoted to the interests of teachers of Nature subjects. These will report the results so far attained, and will suggest topics and methods of treatment, or assist in solving difficulties that may arise. We hope to receive assistance in this work from leading teachers, and to make these bulletins both interesting and useful to the schools.

"But, aside from this, we trust that you will feel free to consult us on any matter relating to this department of work. No teacher can be expected to be familiar with all branches of Nature, or with all the details of any branch. When difficulties arise in matters of knowledge, as well as of method, we shall be glad to help you. The strange weed or flower, or tree; the new insect or bird; the peculiar rock or mineral; the latest disease to attack the crops—all such topics we shall be prepared to investigate on the one condition that they are of interest to an humble learner somewhere. In this we shall have the active assistance of the various departments of the Agricultural College and of prominent teachers in other institutions.

"The Macdonald Institute has been presented to the people and the schools; it remains for us to make the fullest use of the advantages that it is able to offer."

Further Dr. Muldrew purposed establishing extra-mural courses in Nature Study for the benefit of teachers who could not attend the Institute. Outline studies would be sent to registered teachers, and on the satisfactory completion of a certain number of these studies as evidenced by the reports, collections, drawings, paintings, etc., which indicate investigation, credit would be given and a certificate issued. By such ultra-mural courses he hoped to train a much larger number of live, active teachers than he could possibly have in actual attendance at the Institute.

Furthermore, Dr. Muldrew was strongly impressed with the importance of the newer movements afoot for doing more effective work in rural dis-

tricts, such as Consolidated Schools with their collecting vans, better buildings, and school gardens; Travelling Instructors for Rural Schools; and Agricultural High Schools with their school gardens, experimental plots, and arboretums. He saw clearly, however, that there was a pressing need for teachers properly qualified for the new work, and he was making plans for supplying this need at the Macdonald Institute, which is in close affiliation with the different departments of the College proper.

The Education Department at the present time recognizes the non-professional training given at the College in the following way:

"Certificates in Agriculture and Horticulture, entitling the holders to teach Agriculture or Horticulture and Nature Study in the Public Schools of Ontario, subject to the regulations of the Educational Department as to Model or Normal School Training, will be given to Associates who—

"(a) Get at least 40 per cent. of the marks in each of the following subjects of the final examinations for the Associate Diploma, and 50 per cent. of the aggregate thereof: English literature and composition, agricultural physics, agricultural chemistry, economic botany, economic entomology, horticulture, agriculture, and dairying.

"(b) Spend an additional year at advanced study and work in Agriculture or Horticulture, as prescribed below, including a six weeks' course in Nature Study (April 17th—May 31st), with practical tests and examinations immediately afterwards.

"(c) Devote the month of June or July to observation and study of methods and practical operations at the College—plans of cropping; preparation of soil, seeds, and seeding for all crops on the College farm and in the College garden, orchard and plantations; management of live stock; cultivation and harvesting of all crops at the College,—everything on the College Farm and in the Horticultural department.

"(d) Are approved and recommended by the Heads of the Departments responsible for the subjects and examinations mentioned in (a), (b), and (c), taking into account the knowledge of farm work and farm conditions and the ability to teach Agriculture and Nature Study in the Public Schools.

"Graduates who meet the requirements in (c) and (d) for Certificates in Agriculture and Horticulture will be eligible for appointment to teach Agriculture and Nature Study in the Public Schools and High Schools of Ontario, as soon as they comply with the requirements of the Education Department as to training in the Normal College."—(College Circular.)

Arrangements, it was hoped, might be made with the Education Department whereby the professional training would also be given at the Macdonald Institute in Pedagogy, Psychology, and Methods of Teaching. By these means the Macdonald Institute would accomplish the end for which it was erected.

V.—What is Nature-Study?

Many people do not understand the exact significance of the term *Nature Study*, consequently there is much confusion in the public mind as to the importance of the new educational movement with Nature Study as the focus of the disturbance. In reality Nature Study is a pedagogical term (used for want of a better one), and this will account largely for the popular misunderstanding of its meaning.

Nature Study is a *method of study*, and not, primarily, a subject of study. It is a means of developing mental power in the pupil under the

careful guidance of the teacher, by encouraging close observation of the things of Nature, which lie about him, and by begetting an attitude of inquiry into their meaning so that the truth is discovered through the exercise of the pupil's own self-activities.

It is quite true that there are other values in Nature Study, but they are secondary, viewed from a pedagogical standpoint. With many persons the acquisition of information about the things of Nature by a study of Nature is the chief aim; while with others the development of a sympathy with, and an interest in, the common things that surround them is the only value in its study. These secondary values are very great, but they can be realized as a matter of course by making method the chief aim of Nature Study. Now we have Sympathy, Information, and Method, but the greatest of these is Method.

In my judgment, the main reason why Nature Study has not met with that measure of success which its advocates had hoped for in many places, has been the placing of the emphasis on the wrong value and on the wrong aim.

It will be inferred, therefore, that the teaching of Nature Study is not easy. Success will depend almost entirely on the teacher, since it is a method of study. It is comparatively an easy task to fill the minds of pupils with information about Nature, but this is not Nature Study. The true teacher must be a patient, sympathetic guide, acquainted with the mental peculiarities of each pupil and with the subject to be investigated, so as to be able to direct the activities and sustain the interest of the pupil to the discovery of truth for himself. For lack of these qualities many teachers will fail in Nature Study work in school.

Perhaps some persons are asking: "What is the difference between Elementary Science and Nature Study?" Elementary Science is rather a subject of study, and always carries with it the idea of classified knowledge, obtained by a systematic and logical study of the subject. Of necessity the natural interests and activities of the pupil must not stand in the way of the logical development of the subject, and that viewed from the standpoint of the adult, who is trying to inculcate general laws and principles. Nature Study, on the other hand, is a Method of Study where the teacher uses the natural objects and adapts them to the questioning experiences of the young child. In the words of Prof. C. B. Scott, Nature Study is "Nature studied in its relations to the child, from the child's standpoint, by the teacher with the children."

Prof. L. H. Bailey has well said: "When the teacher thinks chiefly of his subject, he teaches a science; when he thinks chiefly of his pupil he is teaching Nature Study."

It may be interesting just here to compare the views of several prominent educationists with regard to Nature Study.

Prof. P. Geddes: "The habit of observing and thinking for one's self and at one's best, without books or help, in the presence of the facts and in the open air."

Prof. Lloyd Morgan: "A means by which simple natural objects acquire meaning."

Prof. M. E. Sadler: "Nature Study is not a subject, but an influence which permeates the whole range of school studies and affects the intelligence and point of view of teachers and pupils."

J. Dearness: "Nature Study from the public school teacher's point of view is the maintaining in educative directions the child's natural interests in its environment."

Prof. G. F. Hodge: "Nature Study is learning those things in nature that are best worth knowing, to the end of doing those things that make life most worth the living."

Prof. C. B. Scott: "Nature Study is nature studied in its relations by the child, from the child's standpoint, by the teacher with the children."

Prof. L. H. Bailey: "Fundamentally, Nature Study is seeing what one looks at and drawing proper conclusions from what one sees; and thereby the learner comes into personal relation and sympathy with the object."

VI. The Advantages of Nature-Study.

Apart from the real aim of Nature Study in education, which has already been discussed, it is clear that many advantages will flow directly from its introduction into our schools. Sir George Kekewich of England says: "There is surely no kind of teaching which confers upon our children so many and varied advantages."

In an article by W. M. Webb, entitled "Nature-Knowledge: Its Progress and Interpretation," published in the *Record of Technical and Secondary Education* of October, 1902, the advantages of Nature Study are well summarized as follows:

"1. To interest the pupils and give opportunities to those whose genius is not in line with ordinary school subjects.

"2. To afford a general preparation for life and success in the world.

"3. To encourage spontaneity and the power of acting for one's self under new conditions.

"4. To make men better citizens, and better able to cope with their living environment.

"5. To cultivate a love of the beautiful and to add to the enjoyment of life.

"6. To develop culture, refinement, and humility.

"7. To form an ideal stepping stone to science.

"8. To improve health.

"9. To stay the rural exodus."

VII.—The Agricultural Phase of Nature Study.

It must be admitted that the study of Agriculture in our rural Public Schools has not been on the whole successful. This partial failure at least is to be attributed to several causes: the inability of the majority of teachers to teach the subject through lack of knowledge of, and want of interest in, rural conditions; the absence of proper equipment for the teaching of a difficult and complex science, thus making it wholly a bookish study; and the placing of a premium on information pure and simple, or cram, which must inevitably lead to mental nausea in both teacher and pupils. In the few cases where teachers were successful in their efforts they taught not Agriculture but Nature Study. To give Nature Study an agricultural trend is quite possible and practicable; in fact, to give it any other trend in rural sections would be wrong.

It must be admitted, also, that in rural schools the courses of study in the past have had too little reference to the lives of the pupils, and as a rule, very little interest had been awakened at school in the common things of the country. The plants of the roadside and field, the birds, the insects, and the soil were less interesting than the pyramids of Egypt or the dwarfs of Central Africa. The central idea in rural education should be a preparation for complete living on the farm. This can only be effected

when the rural people are brought into sympathy with their life work by a study of their surroundings.

It is believed that Nature Study is the best, the only natural means for adding new interest to the life of the country pupil. It is Nature's own method of training her children. The child instinctively interested in the simple natural objects about him, under careful guidance, will be led to investigate them, and to find out their meaning. The child has an inbred spirit of investigation, and if this is properly directed, it will yield him results of great educative value. The farm and its surroundings would become more interesting, and have a deeper meaning to the child. Country life would become more satisfying, because the things of the country would become part of his life. Moreover, the information which he gains in his studies of Nature would become of service to him when he leaves school to begin the more serious operation of farming. His studies of the unfolding of the plant from the seed, bulb, and tuber, have made him familiar with the conditions which govern growth; his garden plot has already made him an intelligent gardener: he knows the habits of the weeds which come up, as it were, to compel him to stir the soil; he has become acquainted with the wireworm, the cutworm, and the borer; he knows the common diseases of plants, and the birds which help him in fighting insects; in short, his Nature studies would help him at every turn.

School Gardens. In our efforts to arouse an interest in Nature Study, we are urging the introduction of school gardens. The educative value of such gardens has been tested for many years in Europe and in some of the States of the Union. They appear to be the best means of arousing in the parents an interest in Nature Study and the work of the school. They furnish a bond between home and school interests, and the parents can readily see that school life and studies, instead of being unrelated to rural life, are after all a preparation in the very best sense for life's work.

School gardens are also valuable because they emphasize the importance of "learning by doing." Besides, garden work can be readily correlated with the other subjects of the school programme. In many districts of Germany the whole school curriculum is based on garden-making and garden-keeping. Note, for example, some of the many topics for investigation that may arise in connection with garden work.

Make a *Calendar* of dates of planting the various vegetable seeds when there is a succession of vegetables through the season.

Make a diagram showing the succession of vegetables.

What vegetables may be planted in fall?

What planting of perennial flowering plants should be done in the fall?

Special Topics for discussion and investigation:

(a) The site and aspect of the garden.

(b) The soil and its improvement by spade-work, draining and manuring.

(c) The build of a plant.

(d) What a plant is made of.

(e) How plants are nourished.

(f) Sap and its movements.

(g) Conditions of healthy growth.

(h) Germination, growth, flowering, fruiting, and seeding.

(i) Annuals, biennials, and perennials.

(j) Evergreen and deciduous trees and shrubs.

(k) The dependence of plants upon insects.

(l) The effect of choosing for seed the larger or smaller samples.

(m) The effect of early and late springs on vegetation.

Some Arithmetic questions:

(a) The garden account.

(b) The number of plants to fill a given space.

(c) The comparative cost of two plots treated differently.

(d) The calculation of the percentage of sound seeds in a sample for a germination test.

(e) The calculation of the loss by insects, by fungi; and the gains by beneficial birds, frogs, and insects.

Some geometry problems:

(a) The laying out of plots in various forms.

(b The construction of plants to scale.

(c) The slope of the garden.

Drawing in connection with School Gardens:

(a) The making of diagrams to illustrate important facts of plant and insect life.

(b) Drawings from Nature of beautiful flowers and leaves.

It is believed that the introduction of school gardens will stimulate not only the teachers and scholars, but also the parents, to take a greater interest in the appearance of the school grounds, which are too frequently neglected. The people of this Province have not yet realized the direct and indirect benefits that may come to the children and themselves by the possession of neatly-kept school premises. Dull, unsightly buildings and grounds will surely keep the tastes and habits of the community on a low level, but well-ordered schools with pleasing surroundings will unconsciously express themselves in better living and higher ideals on the part of both pupils and parents.

That Nature-Study will be a potent factor for this betterment there can be but little doubt, and here lies a great, wide field of work for the Macdonald Institute.

VIII.—The Training of Teachers of Nature Study.

We have ever kept before us the two great needs of the teacher of Nature Study,—(1) an intimate knowledge of the laws of development of the child, how the mind operates, the needs and interests of the child, its activities and its sympathies, and (2) a knowledge of plants, animals, and rocks, and the forces operating upon them. The latter need seems to us to be even more essential at the present time than the former. As a writer has well said: "It is comparatively easy to humor a child's interest, but it requires the teacher's best skill to sustain that interest and guide it to an educative issue."

Inasmuch as we were dealing mainly with teachers of experience who had already some acquaintance with educational psychology, we devoted most of our time to the supplying of the second need. As will be seen from the syllabus of the courses given, we tried to give the teachers in the three months a fairly wide knowledge of the world around them. The training given, however, differed somewhat from the teaching of the ordinary academic laboratory, for there was this distinct object in our mind that at the end of the course the teachers were to depart enthusiastic lovers of Nature. Again, field excursions were made more prominent than usual, to the end that the teachers might know Nature in all her moods.

Some idea of the work to be done by the teacher with our assistance may be gathered from the following note for the student, prefacing the "Outlines

of Nature Studies" prepared by Mr. Jarvis and myself, as a guide for the observational work of the class:

FOR THE STUDENT.

1. Every student shall record daily one observation in the *Nature Study Journal.*

2. Every student shall keep a careful record of the observations made during excursions.

3. The *Note-Book*, with its observations and drawings, will be frequently examined, and the progress of the student will be largely determined from the Note-Book.

4. Every student is expected to make the following collections and to mount them in the most approved manner:

(1) SEEDS.
- (a) Weed Seeds 25
- (b) Cultivated Plants 15
- (c) Trees and Shrubs 10

(2) PLANTS.
- (a) Weeds 15
- (b) Trees 15
- (c) Wild Plants 10
- (d) Ferns 5
- (e) Grasses 6

(3) INSECTS.
- (a) Injurious Insects 25
- (b) Species, representing as many orders and families as possible 50
- (c) Specimens of injuries done by insects 20

(4) ROCKS AND MINERALS.
- (a) Kinds of Rock 12
- (b) Minerals 10

(5) FUNGUS DISEASES.
- (a) Saprophytes 10
- (b) Parasites 10

(6) ECOLOGICAL.
- (a) Leaves.
- (b) Twining Plants.

5. Every student shall keep a Meteorological Record.

In order to develop the power of investigation of the teachers, every member was assigned one of the following problems, to be worked out without assistance, the results to be handed in as a report:

Special Problems.

1. Twining and climbing plants.
2. Twigs of our native trees.
3. Germination of seeds.
4. Shrubs of College Campus.
5. Woods of our Native Trees.
6. Fertilization of plants.
7. Saprophytic plants.
8. Leguminous nodules.
9. Parasitic plants.
10. Greenhouse pests.
11. Leaves.
12. Plant colors.
13. Wheat plant and its products.
14. Flax plant and its products.
15. Cones.
16. Mushrooms
17. Burrows made by animals.
18. Earthworms.
19. A stream.
20. The Toad.

21. Cultivated plants.
22. Hibernating insects.
23. The Chipmunk.
24. Soils.
25. The Crow.
26. Fruits.
27. Glandular plants.
28. Guelph Rock.
29. Apple scab.
30. Aquatic insects.

With the results of the year's work in this Department we feel very much gratified. The progress of every student was very rapid, and the enthusiasm never waned. The exhibition of the Collections and Records in the large Nature Study room during the last week of the course was most excellent, and was not only an object of admiration, but also a source of inspiration to the large number of visiting teachers.

Respectfully submitted,

W. LOCHHEAD,

Acting Director of Nature Study Department.

INDEX.

Abitibi soils, 62
American Colleges, Observations in Physics, 30.
Analysis of College Report, 7.
Animal Husbandry, Report of Professor, 97.
Animal Husbandry, Report of Lecturer, 89.
Apiculture, Report of Lecturer, 142.
Apple, Diseases of, 43, 48, 49.
Associate Diploma Recipients, 8.
Attendance at College, 4, 7, 150.

Bachelors of the Science of Agriculture, 8
Bacon, Canadian and Danish, 89.
Bacteriology, Report of Professor, 117.
Barley, 93.
Bean, Bacterial Disease of, 122.
Biology, Report of Lecturer, 38.
Biology, Report of Professor, 35.
Blatchford Sugar and Flaxseed Feed, 85.
Bramble Diseases, 44.
Buttermaking Experiments, 81, 85.

Cabbage, Black Rot of, 122.
Canned Goods for Export, 67.
Cauliflower, Soft Rot of, 123.
Cheese Experiments, 74-81.
Chemistry, Report of Lecturer, 66.
Chemistry, Report of Professor, 50.
Cherries, 109.
Chicken Fattening, 140.
Cold Storage for Butter, 85.
Consolidated Rural School, 4, 154, 166.
Co-Operative Testing of Small Fruits, 104.
Corn, 93.
Cream Experiments, 82, 83.
Creelman, President G. C., Report of, 3.
Cucumber Wilt, 121.
Cumming, M., Report of, 97.
Currants, 9.

Dairy Bacteriology, 123.
Dairy Herd, 86.
Dairy Husbandry, Report of Professor, 73.
Dairy School, 74.
Dairy School Certificates, 10.
Dean, H. H., Report of, 73.
Day, G. E., Report of, 89.

Egg Hatching, 136.
English, Report of Lecturer, 19.
Evans, John, Report of, 156.
Excursions, 6.
Experimentalist, Report of, 129.
Experimental Work, 131.
Export Trade with Great Britain, 67.
Farm Superintendent, Report of, 89.
Feeding Stock, 94.
Financial Statement, 12.
Field Husbandry, Report of Professor, 129.
Fire Blight, 123.
First Class Men, 9.
Flour and Wheat, 54.
Foul Brood, 125.
Fowl, New Breeds Added, 139.
Fruit, Shipping and Storage Tests, 25, 29, 33.
Fungicides, 63.
Fungus Diseases of Fruits, 40.

Gamble, W. P., Report of, 66.
Geese, 139.
Geology, Report of Professor, 35.
Gooseberries, 110.
Graham, W. R., Report of, 135.
Grape, Diseases of, 45.
Groselles, Fungus Diseases of, 45.

Harcourt, R., Report of, 50.
Harrison, F. C., Report of, 117, 143.
Home Economics, 147.
Horticulture, Report of Professor, 102.
Hutt, H. L., Report of, 102.

Insecticides, 63.
Insects, 40.

Jarvis, T. D., Report of, 38.
Librarian, Report of, 143.
Lightning Investigations, 23.
Live Stock Experiments, 96.
Lochhead, W., Report of, 35, 158.

Macdonald Institute, 4, 102, 147, 159.
Mangels, 93.
Manual Training, Report of Director, 152.
Manual Training and Agriculture, 153.
Matron, The, 5.
Molasses Cattle Food, 85.
Moulting, Forcing, 138.
Muldrew, Dr. W. H., the late, 158.

Nature-Study, 36, 154, 158.
Nature Study, Report of Acting Director, 158.
Needs of the College, 6.

Oats, 92.
Orchard Cover Crops, 105.
Orchard Fruits, 109.
Ornamental Shrubs, 113.

Parchment Paper, dry or moist, 84.
Pasteuring Milk vs. Pasteurizing Cream, 82.
Peach, Fungus Diseases, 43.
Peaches, 109.
Pears, 109.
Pepsin vs. Rennet for Cheesemaking, 75.
Physician, Report of, 145.
Physics, Report of Professor, 19.
Plums, 109.
Potatoes, 93.
Poultry, Report of Manager, 135.
Poultry Houses, 137, 138.
President, Report of, 3.
Prizes, 10.

Quinces, 109.

Raspberries, 109.
Reed, F. H., Report of, 17.
Reed, J. H., Report of, 70.
Rennet vs. Pepsin for Cheesemaking, 75.
Residence, Report of Dean, 17.
Reynolds, J. B., Report of, 19.
Roup, 126.
Rowsome, H. R., Report of, 142.
Rural Schools and Macdonald Institute, 4, 154, 166.

Scholarships, 10.
School Gardens, 171.
Short Courses, 5.
Shrubs, Ornamental, 113.
Soil Physics, Extension of Work, 34.
Soils, Analysis of, 23.
Soils, 60, 62.
Staff Changes, 3.
Stewart, Dr. W. O., Report of, 145.
Stock Judging, Short Courses in, 71.
Strawberries, 110.
Students, 7.
Sugar Beets, 54.
Swamp Soils, 60.
Swine Experiments, 97-101.

Teachers' and Nature-Study, 172.
Tomatoes, 110.
Tuberculin Tests with Cattle, 125.
Tuberculous Cows, Milk from, 125.
Turnips, 93.

Vegetable Garden, 110.
Veterinary Science, Report of Professor, 70.

Watson, Mary Urie, Report of, 147.
Wax Models of Fruit, 116.
Weather Report, 32.
Weed Seeds, 36.
Weed Spraying, 39.
Wheat and Flour, 54.
Winnipeg, Fruit Shipping to, 25, 108.

Zavitz, C. A., Report of, 129.

UNIVERSITY OF ILLINOIS-URBANA
3 0112 112411175